SCIENTIFIC AMERICAN

No. SUPPLEMENT 215

Scientific American Supplement, Vol. IX., No. 215. | NEW YORK, FEBRUARY 14, 1880. | Scientific American Supplement, $5 a year.
Scientific American, established 1845. | | Scientific American and Supplement, $7 a year.

EXPLANATION OF THE BOGIE SYSTEM OF LOCOMOTIVES.

THE peculiarity of this type of locomotive consists mainly in the system of bogies, or trucks, on which it is carried, all its wheels being grouped in flexible trucks of two, four, or six wheels, as circumstances require.

The boiler and tank are united in one rigid structure, instead of being divided into two separate machines, as in the ordinary varieties of locomotives. This arrangement prevents either end from wabbling about independently of the other, and gives great steadiness throughout.

The boiler and tank thus united form the body of the engine, which, like the body of a car, is mounted on bogies. By means of the flexibility of these bogies with their springs, equalizers, jointed steam pipes, etc., the whole working machinery becomes perfectly articulated, which allows the wheels to follow all the undulations of the track, and so divides its inequalities through the whole system that the disturbing forces are reduced to a minimum, or nearly lost.

The body of the engine, therefore, glides along as quietly and smoothly as a Pullman car.

It runs either way equally well, and will turn the sharpest curves with perfect ease, and without cutting the flanges of its tires or spreading the rails. Roads using these locomotives can have the rails on their curves set up to the regular gauge of the track instead of spreading them, as is necessary where the common type of engine is used.

This system is particularly advantageous on a narrow gauge, not merely on account of the facility with which these engines turn quick curves and climb steep grades, but especially for the amount of space allowed the firebox. This feature alone would seem to make the system indispensable. The firebox being situated between the trunks (not between the wheels, as in other engines), can be made of any width or length desired; in fact, there is nothing in the way, and the boiler can be made of the most approved proportions without interfering with anything.

This accounts for their steaming qualities, their economy in fuel, and also their wonderful performance on long steep grades, where they never "get out of breath."

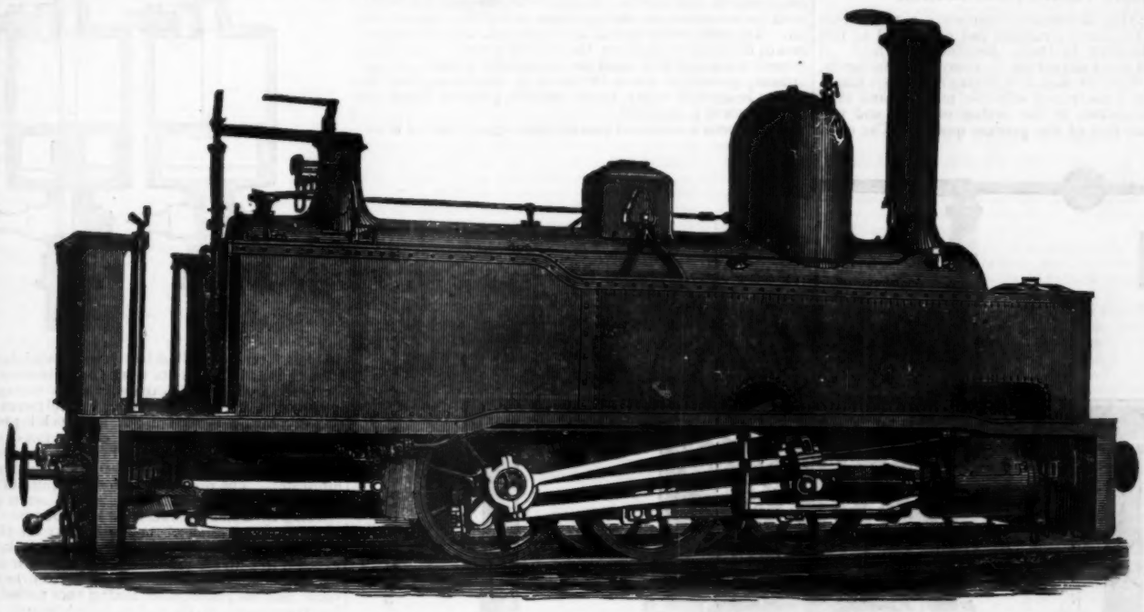
The smaller engines of this type are mounted on two trucks of four wheels each, the larger ones on two trucks of six wheels each, with, in some cases, an additional leading truck of two wheels. Thus the several sizes have from eight to fourteen wheels, while the old varieties, including tenders, have from sixteen to twenty. In this item there is quite a saving in wear and tear of extra wheels and axles, with their boxes, journals, springs, etc., as well as in the consumption of oil and destruction of rails.

Its power is extraordinary, the entire weight of the boiler and its attachments being on the steam truck adds so much to the tractive power, that with its superior steaming qualities the engine is able to haul immense loads. Some good taste has been displayed in bringing this system to a practical form, and consequently the machines are graceful in appearance. They are well arranged for the accommodation and comfort of the engineer and fireman, and ride so smoothly, without any jarring motion, that the men can run them more hours a day than other engines.

The system has arrived at a high state of perfection, and is recommended with confidence to the railroad public for all purposes of locomotion. Made by the Mason Machine Works, Taunton, Mass.

SIX-COUPLED TANK LOCOMOTIVE.

WE give a perspective view, from *Engineering*, of one of the class of six-coupled tank locomotives for the meter gauge constructed by Messrs. Cail & Co., of Paris, for contractors' purposes. The engine has outside cylinders and outside valve gear, and all the axles are under the barrel of the boiler. The water is carried in wing tanks, and the fuel in bunkers at the sides of the firebox. The leading and trailing buffer beams are carried down very close to the rails, so as to support the engine in the event of derailment, a by no means uncommon occurrence on rough lines laid for contractors' use. The deep buffer beams are also convenient in permitting of the arrangement of the draw gear at different heights to suit the various classes of vehicles used by contractors. The chief dimensions of the engine are as follows:



SIX-COUPLED TANK LOCOMOTIVE.

	ft.	in.
Diameter of cylinders	0	9·84
Stroke	1	2·17
Diameter of wheels	3	1·5
Wheel base	5	7·7
Mean diameter of barrel of boiler	2	10·6
Length of firebox inside	3	1·6
Width " "	2	2·2
Height " crown above grate	3	1
Number of tubes 81		
Diameter of tubes outside	0	1·77
" " inside	0	1·61
Length of tubes between tube plates	7	11
Diameter of chimney (inside)	0	9·84
Working pressure ..... 128 lb. per sq. in.		

BOGIE LOCOMOTIVE FOR THE DENVER, SOUTH PARK & PACIFIC (3-FT. GAUGE) RAILROAD.

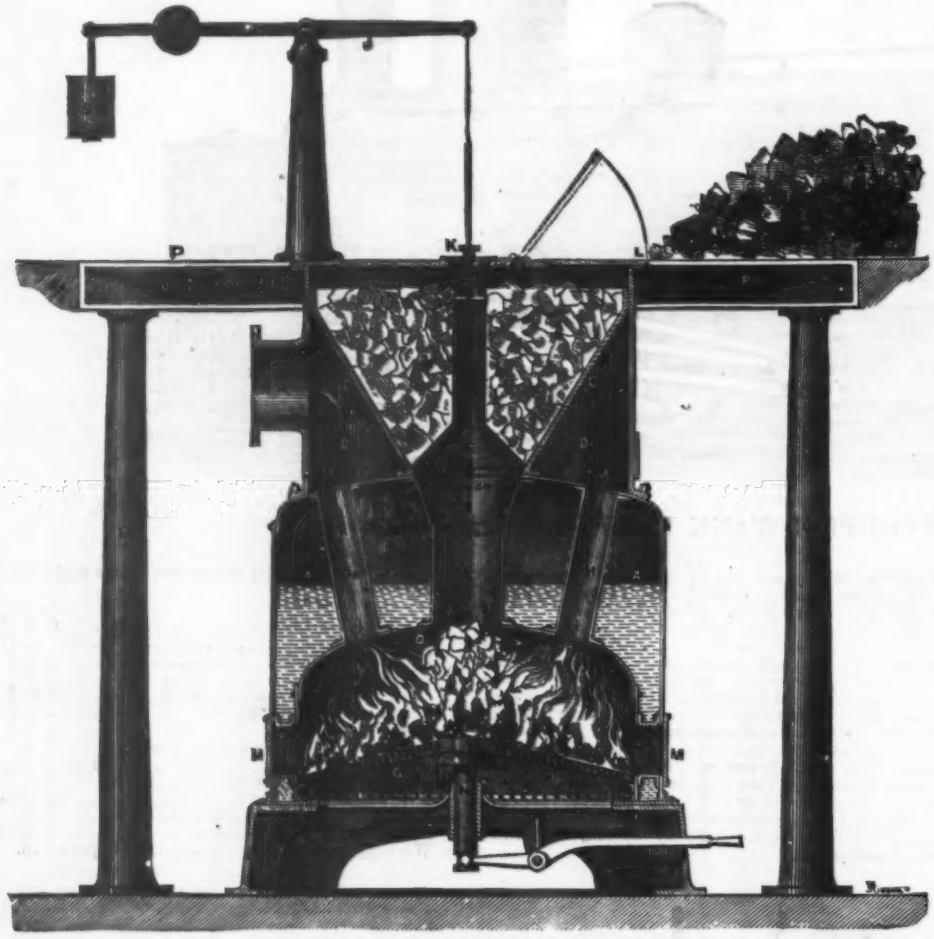
	sq. ft.
Heating surface, firebox	38·4
tubes (outside)	297
Total	335·4
Firegrate area	6·8
Flue area through tubes disregarding ferrules	1·23
Sectional area of chimney	0·53
Ratio of grate surface to total heating surface	1 : 49·3
Ratio of flue area through tubes to grate area	1 : 5·53
Ratio of sectional area of chimney to grate area	1 : 12·8
Contents of water tanks	242 gals.

	tns.	cwt.
Contents of coal bunkers	0	6
Weight of engine, empty	9	16
Weight in working order:		
On leading wheels	4	0
" driving "	3	18
" trailing "	4	2
Total	12	0

The boiler is fed by one Friedmann injector and one Chiazzari feed pump, the latter being a kind of combined feed pump and water heater, with which some very satisfactory results have been obtained in France and Italy. We hope to describe it fully on some future occasion.

CENTRAL FEED STEAM BOILER.

THE accompanying illustration represents a new steam boiler, designed for burning rubbish and other fuel of low quality, by Thwaites Brothers, Bradford, England. It promises to be of great advantage to many manufacturers, as it will afford them the means of getting rid of their manufacturing waste in a ready and effective manner, and even with profit to themselves in the saving of fuel, and will enable them to use fuel of the poorest quality. The chief



CENTRAL FEED STEAM BOILER.

features of this boiler will be readily perceived on reference to the engraving. A A represents the boiler; B is the furnace; C the feed hopper; D the smoke box surrounding the hopper; E the central feeding shaft through which the fuel passes from the hopper into the furnace, B; F, balanced conical bell valve, by which the mouth of the feeding shaft, E, is closed or opened; G, fire bars; H H, flue tubes leading from fire box, B, to the smoke box, D; R, branch leading from the smoke box to the chimney flue; J, lever arm for working conical bell valve, F; T and S, balance weights for ditto; K, air valve which rises with the rod when the feed valve is lifted to admit a fresh charge of fuel, and sinks gradually back to its seat, so as to facilitate the combustion of the smoke; L, lid or door by which the fuel is fed into the hopper; M M, doors placed at intervals round the boiler for clearing out ashes and clinkers; N, central support for fire bars; O, lever for raising and lowering ditto; P, upper platform for reception of the refuse fuel, and for feeding hopper; Q Q, pillars supporting upper platform. The gases thrown off from fuel in drying in the hopper pass through the perforations and down the tube, forming the upper portion of the bell valve, F, down the central feeding shaft, through the furnace, up the flue tube, H, through the smoke box, and out into the chimney flue, in the direction shown by the arrows.

The principal advantages claimed for this boiler are: 1st, a very large area of grate surface; 2d, a large and wide spread combustion chamber, with several flue tubes leading therefrom; 3d, the refuse fuel fed into the center of the circular furnace from a hopper placed above, instead of by the ordinary fire doors; 4th, the feed hopper fixed in the smoke box, so that the rubbish contained therein may be thoroughly dried by the waste heat in the smoke box before passing into the furnace; 5th, the noxious gases given off from the fuel in process of drying are carried through the fire, and thereby purified before being allowed to pass out into the flue and thence to the atmosphere.

One important purpose to which the patent boiler is capable of being applied is that of affording a means of easily and profitably disposing of night soil, ashpit refuse, and other continuously accumulating solid refuse of towns and inhabited districts. This is usually disposed of in a very imperfect manner, by simply removing the nuisance from one locality to another, that is, by depositing the refuse upon the land wherever a convenient "tip" may be found. In course of time, as the nearer "tips" become filled up, more distant sites have to be found, and the cost of removal soon becomes a very formidable item. Moreover, this "made ground," composed of all manner of decomposing filth, eventually gets built upon, producing permanently unhealthy habitations, from which disease seems hardly ever absent. The best and most innocuous, and on the whole the cheapest mode of disposing of this solid refuse is pronounced by competent authorities to be the burning of it in specially arranged furnaces. It is designed in the central feed boiler, while thus disposing of the refuse, at the same time to turn it to valuable account by raising steam therewith, to be employed as motive power. In this way it will form a valuable adjunct to Isaac Shone's pneumatic sewerage system, as it will dispose absolutely of the question of the cost of producing the compressed air power employed in that system, inasmuch as no coal whatever need be consumed in raising steam power to compress the air. The solid refuse and filth is destroyed, and in its process of destruction produces the motive power required to remove the liquid filth upon the pneumatic system, or by ordinary pumping, where the latter is already applied; or it may be applied to any other suitable purpose wherever motive power is required.

It has been ascertained that noxious organic matter is entirely destroyed at a temperature of 480° Fahr. All the gases arising from the refuse fuel will therefore be thoroughly purified by being passed through the furnace. The residue also—viz., the ashes and clinkers from the furnace—will be rendered perfectly pure and harmless, and could be made up into mortar, or used as road ballast, or for footpaths without any fear of creating a nuisance.

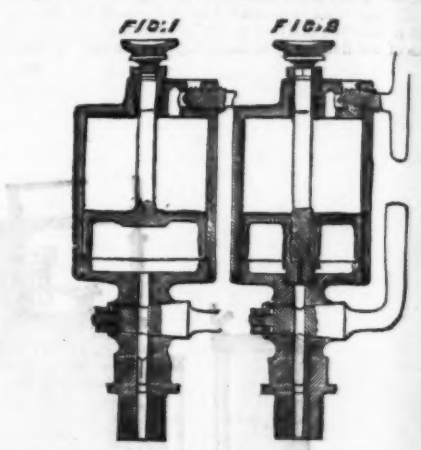
In solving the difficult and vexatious problem which local authorities have to face in the disposal of town refuse, as well as in providing for the consumption privately of manufacturing waste, and the economical use of poor fuel in raising steam, a wide field is open for the employment of inventions like the one before us. With the guarantee for the excellence of their manufactures which the high reputation of the firm affords, we do not doubt that Messrs Thwaites' boilers will be largely and very advantageously adopted by corporations and manufacturing companies—*Colliery Guardian*.

STEAM PRESSURE LUBRICATORS.

THE improvements in lubricators recently patented by Messrs. Dewrance & Wall, of Great Dover street, Borough, Eng., depend in principle on the action of the steam forcing a piston against the oil, a part of which finds its way to the surfaces thus lubricated.

The oil or other lubricant is contained in a cylinder provided with a piston, and is subjected to a pressure which preponderates somewhat over the pressure of the steam or other fluid. The result is obtained preferably by admitting the steam or other fluid to one side of the piston, and diminishing the area of the other side which presses upon the lubricant, or a spring or weight, operating to produce the required difference of pressure on the lubricant, may be used. In the arrangement which the patentees believe to be the most convenient, the passage intended to convey the lubricant to the place where it is required, and in which may be a cock or valve, has a cylinder mounted upon it containing a piston, having on one side a rod passing out by a stuffing box through the cover of the cylinder. On the same side of the cylinder is a suitable filling opening, through which the lubricant is introduced. The area of the side of the piston which is exposed to the steam or other fluid being larger than that which is exposed to the lubricant, the initial pressure per square inch of the lubricant preponderates, and causes it to find its way past the piston by a small aperture which may be capable of regulation. Thus the lubricant enters the side of the cylinder which is open to the steam or fluid, and thence it drains away to the part to be lubricated. The greater pressure on the lubricant prevents the steam or other fluid from entering and mixing with it, thereby avoiding the inconvenience which is sometimes experienced with other lubricators. An adjustment of the quantity of lubricant expended may be obtained by applying a weight or spring to the outer end of the piston rod. The piston rod serves also to indicate the quantity of oil contained in the cylinder.

Fig. 1 is a vertical section of one of these lubricators in its



simplest form. A cylindrical vessel, containing a piston, so fitted to it as to be able to work freely, is screwed to a tubular foot, through which there is a free passage for the entrance of steam, and for leading the lubricant away to the part at which it is wanted. A stop-cock is provided in the foot, by which the lubricator can be put out of use when lubrication is not required, or by which the steam under the piston may be discharged when it is desired to refill the lubricator. The piston has a rod passing out by a stuffing box through the top of the cylinder. A screw plug closes an opening by which the lubricant is poured into the cylinder, so as to fill the whole of the space above the piston. On the admission of steam beneath the piston, the lubricant being exposed to a higher pressure per square inch than the steam, by the amount due to the sectional area of the rod, gradually oozes past the piston, and, having once passed the piston, it has free passage to the part to be lubricated. If the piston be a good easy fit within the cylinder the quantity of lubricant it will permit to pass will be about the amount required.

Fig. 2 shows an arrangement in which there is power of varying the adjustment. A passage for the lubricant is formed through the piston as well as around it, and in this case the piston is made as good a fit as is consistent with free working. The piston rod is screwed into the hole in the piston, and its lower end forms a cone valve, entering the mouth of a narrow passage, through which, under the influence of pressure, the lubricant flows. By turning the piston rod partly round, this passage can be more or less contracted and an adjustment of the flow effected. The piston rod is made to fit somewhat tightly into the piston, and is grooved at the sides so that the lubricant may be able to pass it. The boss in the center of the piston on the under side is square, and when the piston is down it fits into a corresponding recess in the foot, so that the cylinder may not turn at the time when the adjustment is made by screwing the piston rod in or out.

HOW TO ASCERTAIN THE INCLINATION OF BORINGS.*

IT is well known that bore holes—especially those bored with turning tools—are never perfectly perpendicular, but deviate more or less from the vertical; yet, until now, no method has been devised to find this degree of inclination and also its bearing. As many calculations depend upon depths from the surface, such, for instance, as the temperature of the earth's crust, depth of seams, thickness and dip of strata, etc.; and as these data are generally taken from bore holes, it must be obvious that the correctness of such calculations must depend greatly upon these depths being accurately known. The depth of bore holes is generally taken upon the supposition that they are perpendicular, and that their measured depth is the vertical distance below the surface of the earth; while, in many cases significant deviations have been known to exist, which would give an erroneous result, by denoting a greater depth than is actually the case.

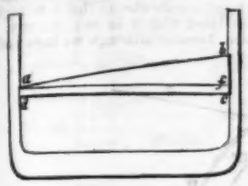
An extremely ingenious apparatus for ascertaining the true inclination of bore holes from the perpendicular, and also the direction of such inclination, has been devised by Herr G Nolten, of Dortmund.

The working of this instrument depends upon the fact of liquids always seeking their natural level, the level thus obtained being rendered permanent by the action of hydrofluoric acid in etching upon glass.

The figure on next page represents a section of the instrument used to obtain the angle of deviation. It consists of a ground flat bottomed colorless glass vessel, the sides of which are exactly at right angles to the bottom.

* Abstract of a paper recently read at a meeting of the Institute of Mining and Mechanical Engineers, Newcastle-upon-Tyne.

Into this vessel is poured one part of hydrofluoric acid to four parts of water, filling it half full.



If the instrument is then placed in an inclined position, so that, for instance, the water level takes the line *a b*, and if kept still for half an hour, the level of the liquid will be marked in the shape of a ring upon the glass, formed in such a manner that, exactly at the level of the liquid, *a b*, the inner part of the glass toward the bottom is eaten or thinned away to a certain depth. Some of the liquid is then taken out, so that its level in a horizontal position will mark itself below the lowest line of the first mark. The glass is now placed on a perfectly horizontal surface, and being kept in this position for half an hour the liquid will make the mark *d c*. By pouring out the liquid, and cleaning the glass, the two marks will be seen clearly and distinctly, while the glass will remain perfectly transparent.

As *a f b* is a right-angled triangle, the angle *b a f* represents the angle of deviation from the perpendicular.

In practice, the glass is placed in a water-tight instrument, having the form of a round ended cylinder, with a rod passing through the top, having screwed ends, of which the top fits into the boring rods or rope used in lowering it. The cylinder is provided with protruding rings or flanges of guttapercha, which prevent the instrument from falling heavily when being lowered. With the exception of these parts, the instrument is made of brass, on account of a magnetic needle which is inclosed. The glass containing the etching liquid is closed with a lid lined with guttapercha and placed in the interior of the cylinder, upon a plate set exactly at right angles to the sides of the cylinder, and the instrument is then lowered into the hole.

The instrument is kept quietly hanging for half an hour at any depth at which an observation is to be taken. It is then drawn up, and the mark etched upon the glass is found unweakened, notwithstanding the lowering and bringing up, since, on account of the constant oscillation of the liquid, the latter etches the surface of the glass equally all over.

After cleaning the glass, the process above described is gone through—that is, a less quantity of liquid is poured in, so that, the glass being held in a horizontal position, the level of the liquid will be a little below the lowest mark of the etched ring. It is now placed again in the instrument, which is allowed to hang freely in a perpendicular position on the surface of the ground for half an hour, or the glass is allowed to stand upon a perfectly horizontal surface.

Having thus obtained these lines, the angle of deviation from the perpendicular at a measured depth of the bore hole is arrived at.

The result being obtained, there now remains to be found the direction of this deviation in a horizontal plane—that is, its magnetic bearing. This is found as follows:

The glass containing the etching liquid is fitted into a ring which is divided into 100 parts fixed concentrically with a case containing a compass, the rim of which is similarly divided, so that in both the zero point and all the divisions correspond. Over the ring first mentioned a brass ring is fitted, which can turn round and is divided into 360 degrees. In order to ascertain the direction of the dip of the instrument, the pointing of the north point of the needle when stopped is read off on the divided rim of the compass; the movable ring is then turned round until its zero point is over the number thus found, and the bearing is read of the lowest point of the etched ring on the glass.

In carrying out this method in practice, it is necessary that the reading of the magnetic needle in the bore hole should be the same when the instrument is brought to the surface, so that the bearing may be read. This is accomplished by fastening the needle while in the bore hole, first allowing it time to come to rest by means of a watch placed over the compass, and provided with a stop mechanism. The watch is set to fix the needle after a certain interval, thus allowing the instrument to be lowered to the measured depth where it is to remain.

By means of a combination of screws and packing, the instrument has been proved to be perfectly water-tight at a depth of 3,280 feet.

The diameter of the instrument, as first constructed, being about 3 in., it could only be used in a 4 in. bore hole. In order, however, to allow of its use in a 3 in. hole, such as can be bored by means of diamond borers, an instrument has been constructed having a diameter of 2¼ in.

This instrument has undergone many trials which gave very satisfactory results as regards its reliability. The tests were made by means of fixed wrought iron tube, the inclination of which was known, readings of the instrument being taken in three different parts of the tube, from the average of which the angle and the bearing of the dip of the tube were deduced, and compared with its true position.

The instrument has been practically tried in five bore holes; named respectively, three of which, "Sirius," "Tellus," and "Berggeist," were put down by percussion boring. The bore hole "Sirius" gave, at depths of 890, 1,100, and 1,230 ft., an equal inclination from the perpendicular of 3°, with a bearing W.S.W. The bore hole "Tellus," at depths 750 and 796 ft., an equal declination of 11° N.W. In the bore hole "Berggeist," at 600 ft., the inclination was 4½°.

In the summer of 1874, the bore hole, "Gustav Adolph," near Dienslaken, bored with a turning borer, was stopped at the depth of 750 ft., with the intention of proceeding with it at some future time, and was tubed all the way. This bore hole was experimented on with Herr Nolten's instrument, and gave the following results: At a depth of 300 ft., the inclination was 2°; at 300 ft., 3¾°; at 430 ft., 8¼°; and at 750 ft., 47°. After this it was decided not to proceed with the boring.

The most interesting experiment made with this instrument was made in the deep bore hole bored by Mr. Fiscus, near Lieth, in Holstein. The result was as follows: At 328 ft. the bore hole was perpendicular; at 656 ft. it had a visible inclination, which at 984 ft. rose to 3°; at 1,640 ft., the inclination was small; but at 2,624 ft., it rose to 1°, and kept at that to a depth of 3 280 ft.

Two experiments were made with the compass at 1,640 feet and 2,296 feet, the first of which showed a bearing of N.N.E., and the latter N.N.W.

NORWEGIAN LIGHTHOUSES.

FRUHOLMS coast light—the most northern lighthouse, not only in Norway, but on the globe, is situated on a lat. 71° 5' N., or but 4 miles more to the south than the North Cape—was established in 1866. The tower, constructed of iron, is 46 ft. high; the total cost was about £7,110.

The most noteworthy of the structures are the lighthouses at Thorbjörnskjœr (outside of Hvalöerne), Aasvœr and Trœnen (both in Nordland), Marstenen, Gjœslingerne, and Hestskjœr. The height of the building ground above the sea level at the four first places is 36 ft., 41 ft., 44 ft., and 78 ft., respectively, but still the sea washes over them all in stormy weather. At Thorbjörnskjœr large granite blocks placed on the highest point of the rock were swept down into the fissures; during the erection of Trœnen and Aasvœr lights the cellars were filled by the sea, and at Marstenen (lat. 60° 7' 45" N., long. 1' E. of Gr.), the door and window of an outhouse was knocked in, although the foundation has an elevation of 72 ft. At Gjœslingerne (lat. 64° 43' 50" N., long. 10° 31' 30" E. of Gr.), and Aasvœr it is still worse. The former rock, which is 72 ft. high, is almost daily washed over by the sea, and the latter is not much better off. When the operations began at Gjœslingerne, the materials which had been landed and brought up to the summit with great exertions, were repeatedly swept away, and it took a considerable time before the workpeople succeeded in getting a firm footing on the dangerous rock. The difficulties to be overcome at this and at most of the other places mentioned above were greatly increased by the total absence of any harbor, anchorage, or landing place, while the swell of the sea is often so great as to make landing perilous. Under such circumstances the materials must be stored in the nearest harbor, and loaded boats or vessels constantly kept on the look-out for every occasion of effecting a transport. When Thorbjörnskjœr lighthouse was in course of construction, it happened that a vessel in the best part of the summer season for three weeks tried in vain to get her cargo discharged.

Gjœslingerne is the most strongly built lighthouse in Norway. Its lower part, up to 40 ft., forms a hollow truncated cone, 35 ft. at the base, with 9 ft. thickness of walls. The materials consist of uncut stones set in a mortar of Portland cement and fine gravel, mixed in a proportion of 1 to 2½ by measure, with a backing of strong concrete on the inside. There are rooms for water, stores, and kitchen. The concrete portion of the tower is surmounted by a cylinder, 20 ft high by 22 ft. in diameter, composed of cast iron plates screwed together, and lined inside with beams. This part contains the dwelling and sleeping rooms of the lighthouse keeper and the lantern.

The lighthouse is exposed to a tremendous sea; in heavy weather it is entirely buried in the surfs, but the lantern, being on the south side, is partly protected by the body of the tower.

The most expensive lighthouse establishment in the country is that at Trœnen (lat. 66° 25' 50" N., long. 11° 59' 50" E. of Gr.), which involved an outlay of £12,620. The tower was constructed of cut stones—there being good quarries in the vicinity—up to a height of 36 ft., with two adjacent wings of the same material. On the top of the stone tower was erected another of iron 42 ft. high. This was the first instance in Norway of combining a tower of large dimensions with a dwelling house. At places where smaller lights were sufficient, and consequently towers of only inconsiderable height required, the tower and the dwelling house have been established under the same roof. This is the case with the above-mentioned lighthouse at Thorbjörnskjœr, which was constructed of granite, with bricks on the inside. It sometimes takes seas through the chimney top, which has a height of 72 ft. above the level of the sea.

The number of lights now in operation along the Norwegian coast is 123.

NAPIER'S "SHOWSPEED," OR SPEED INDICATOR.

THE necessity is constantly occurring in various industries of knowing the speed of a machine in motion, or, in other words, the number of revolutions it accomplishes per minute. When the velocity does not exceed 100 revolutions per minute, the simplest means is to take a point on the part in motion, and to count the number of times it passes before another given fixed point. Beyond 100 revolutions, such an operation becomes difficult, and recourse is had to apparatus of two very distinct classes: (1) revolution counters, and (2) speed indicators.

NAPIER'S SPEED INDICATOR.

The first class, to which may be assigned such instruments as those of MM. Deschiens and Sainte, are very portable, simple, and convenient, but they are nevertheless accompanied by quite a grave defect—they give only the *mean* speed of the machine during the time at which the counter is applied to it, but indicate absolutely nothing as to the regimen of the machine or to the variations of speed that it may undergo. Speed indicators, on the contrary, make known the velocity *at every instant*, show all the variations at the very moment they take place, indicate the amount of such variations, and, by so doing, furnish very valuable information as to the value of *governors* applied to machines in motion.

In a former number of the SCIENTIFIC AMERICAN (vol. xli., p. 131) we have described the "Cycloscope," which is founded on the principles of optics; on the present occasion we present an illustration of a little apparatus which, like Buss' Tachymeter, is based on the laws of centrifugal force.

It is composed of a small cast iron reservoir filled with mercury, and mounted on a pivot, which is rotated by the machine submitted to experiment through the aid of a simple catgut cord. To the reservoir is hermetically luted a glass tube, into which the mercury tends to mount through the effect of centrifugal force. In fact, when the reservoir is set in motion, the centrifugal force creates a vacuum in the center of the reservoir, and the pressure on the mercury causes it to rise in the tube to a height dependent on the rotary speed of the apparatus. A small ivory cork, having an index point, floats on the surface of the mercury in the glass tube, follows all the movements of the mercury, and indicates the speed on a graduated scale. The apparatus thus constituted forms a true *speed manometer*. When at rest, the index point of the ivory float is at zero, as shown in the figure. In a model arranged especially for locomotives, motion is transmitted by a miter-wheel; and a graduation depending on the relations existing between the diameter of the driving-wheels and the speed of the indicator makes known at every instant the number of revolutions of the driving-wheels and the speed of the train per hour in kilometers. M. Napier's apparatus is extremely simple, very easily arranged, and will render very great services in all cases where there is a necessity of knowing the speed of a machine and the variations that this speed undergoes during the different phases of its operation.

FAST SPEED VESSELS.

To the Editor of the Scientific American:

In your issue of September 20th last, and just noticed by another weekly, I read of the English war steamer Mercury; her somewhat wondrous proportions, her speed nearly twenty-two miles per hour.

An item which excites our interest is that her hull is nearly filled with her boilers and machinery, which we may reasonably suppose is found to be necessary to work her twin screws with which she is fitted.

It is hardly necessary to say that war vessels are built for war vessels, throwing economy out of the question. So that like all steamers of the day their consumption of fuel is alarming, were it not that we are accustomed to see such large coal bills.

Now, if the twin-screws of the Mercury were perforated with countersunk holes (see SCIENTIFIC AMERICAN, Aug. 30, 1879), they or perforations would effect a saving of about one and a half tons of coal per hour, and that too with a saving of 20 per cent. steam.

The whole secret of the matter is that it removes the vacuum from the forward side of the blades, and that gone, the power exerted by the engines is in favor of propulsion (see *Engineering*, July 25, 1879, page 78). Mr. Froude, in the next place, showed that the actual resistance to the motion of a ship is considerably less than had been supposed to be the case, judging from the result of steam-measured mile trials; and finally, that an enormous waste of power takes place in screw-ship propulsion. Mr. Froude in his report shows that the Greyhound, a vessel of over 1,000 tons displacement, could be towed at nearly four knots speed, with a strain on the tow-line of only half a ton, at eight knots with a strain of 2½ tons, and at twelve knots with a strain of only nine tons. He says: "A comparison between the indicated horse power of the Greyhound when on her steam trials, and resistance of the ship, as determined by the dynamometer, shows that, making allowance for the slip of the screw, which is a legitimate expenditure of power, only about 42 per cent. of the power exerted by the steam-engine is usefully employed in propelling the ship, and that no less than 58 per cent. is wasted friction of engines and screw, and in the detrimental reaction of the propeller on the stream-lines of the water closing in around the stern of the vessel."

This great man, with a great mind, has discovered or proved the fact that an unseen or unknown enemy is at work depriving the engine of much of its power.

This enemy has now been shown to be vacuum, which deprives scientific men of a large proportion of their labor: and so long as the engineer will continue to use solid blade-wheels, so long must he be deprived of that amount of speed which he knows, by accurate calculation, his engines, boiler, and vessel ought to repay him for his labor and perseverance bestowed upon them—so long will he be troubled with all the annoyances and extraordinary waste of fuel and steam—so long must he look upon the jar and vibration of engine and vessel as a natural consequence of a wheel making revolutions in water which cannot be obvinted.

You ask the same engineer what must be done to stop the shake or vibration observable when a liquid is running or flowing from the bung-hole of a barrel, and he will tell you make a vent-hole—ventilate the barrel, and the liquid will flow quietly, smoothly. You ask another: If vacuum is formed anywhere which I do not want, what shall I do to get rid of it? He will say: Ventilate it. But when it comes to vacuum or displacement in water on the forward side of the blades of a screw-propeller, many hear not what you say. So that so long as engineers and scientific men will try to fight against common sense and natural law they will meet with a signal failure, and that too at a frightful expenditure of fuel, engine, and boiler power.

When natural law steps in and declares you cannot prevail, it is high time for the scientific, at least, to listen to such an unerring voice. It does seem strange that, although the perforated screw-propeller wheel has been proving and maintaining its claims ever since November 12, 1877, on each and every vessel to which it has been applied, and though brought to the notice of the most scientific men of the day through the medium of their journals, against which no one can bring a railing accusation being unable to disprove its many assertions, but few great minds have condescended to give it a moment's consideration (so far as we are aware); one, however, did say, "This will be our future wheel."

Its extreme simplicity and naturalness is its offense. Hence, corrosion or pitting, breakage of wheels and shafts,

are yet common. Vibration is still annoying and expensive; speed gained is not at all commensurate with the enormous outlay of engine and boiler power, fine-lined vessels and steel steamers; cost of fuel is something outrageous; and while every part of the vessel of the present day demands the latest improvement and most careful study, the screw-propeller (of the great steamship), which is the most active and should be the most effective of all, seems to receive but a careless consideration. A steamship from New York to Queenstown in nine days may as well make a saving of sixteen hours; or one from London to Australia in forty days may as well be allowed to perform the trip in from seventy to seventy-four hours less time, and that too with a saving of fuel and with all the other advantages as proven by perforation. It asks but a trial on any wheel, and requires but a run of fifteen minutes from the start of the engine, to prove its advantages.

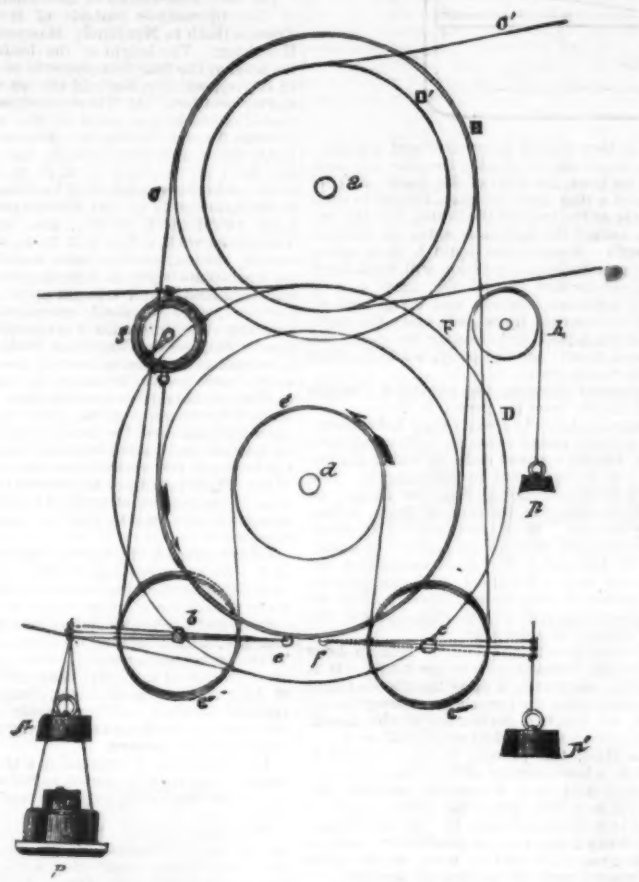
FARCOT'S NEW BALANCE DYNAMOMETER.

THE dynamometer which we illustrate herewith allowes of the power, resistance, and performance of any machine run by belts being ascertained; and that, too, at every instant, whatever be the speed of the mechanism submitted to trial, and whatever be the conditi ons in which it is placed. The principle of the apparatus has for its foundation the measure of the tension of the con duction strain of a belt running from the driving shaft to the shaft driven, and passing around two tension friction rollers, which are loose on their axles and mounted on movable frames, each around a pivot; the latter part of the apparatus exactly representing a scale with a beam, in two pieces, pivoting around two points. The belt in question is stretched precisely at the beginning of the operation by means of equal weights placed on each side of the tension rollers, and in such a way that the conducting strain transmits to the machine submitted to trial exactly the power necessary to cause it to move—this power being ascertained by the dynamometer, as shown further on.

The two frames, A, carry the shafts, *a* and *d*. On the first of these is fixed the pulley, D', which is set in motion by the motor, and the pulley, E, which, as well as the pulley, *e'*, attached to the axle, *d*, we will speak of again. The axle, *d*, also carries a pulley, D, which transmits motion to the machine to be tested.

From this preliminary description it will be at once seen that M. Farcot's dynamometer is nothing else than an intermediate gearing between the motor and the machine to be tested, and that as such it may serve for the transmission of velocity, multiplying it or dividing it according as the machine to be tested is one that moves at a high or a low rate of speed. The two axles, *a* and *d*, are connected by a belt, C', which passes around the pulleys, E *e'*. The proper amount of tension is obtained by means of two rollers, *e' e''*, mounted on the axles, *b* and *c*, and two exactly square weights attached to each of the two frames. A revolution counter, *t*, is connected with the axle, *d*, by means of a belt running over the pulley, *l*. Suppose now, that whatever be the power of the motor, which acts as a distributer of force, we should put the dynamometer in motion by means of the belt, C', leaving out of consideration for the moment the machine to be tested. As a result, the equilibrium would be broken in consequence of the tension of the conducting strain of the belt, C', necessary to move the mechanism. The weight, which serves to establish the equilibrium again, we will call the tare of the dynamometer for a speed of the axle, *d*, ascertained by the tachymeter.

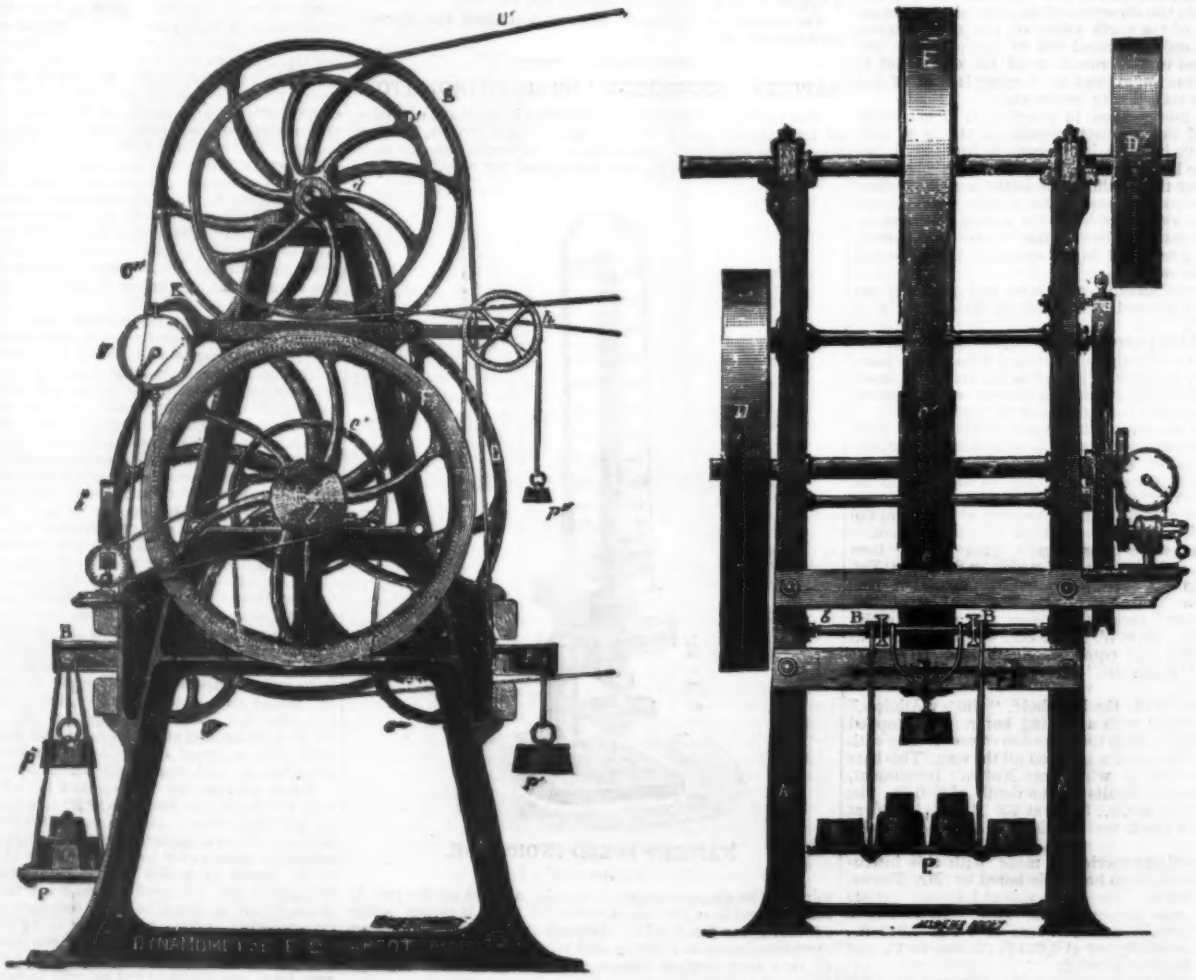
If, now, the machine to be tested be driven by a belt, C, the resistance opposed by it will break the equilibrium of the dynamometer anew; and, as the weight necessary to put on the platform, P, to restore the equilibrium, represents the force of tension of the conducting strain of the belt, C', which is necessary for the operation of the machine that is being tested, the result is that this weight, multiplied by the circumferential velocity (given at once by the tachymeter) of the pulley, *e'*, expressed in seconds, is the number of kilogrammes absorbed per second by the machine submitted to the experiment. A cord passing over a channeled pulley, F (fixed on the driven shaft, *d*), serves, by means of a spring balance provided with an index and actuated by the cord, to verify the experiments which have been made.



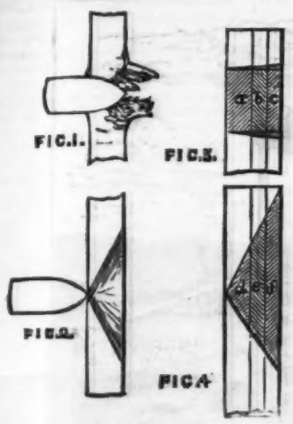
FARCOT'S NEW BALANCE DYNAMOMETER

CHILLED CAST IRON ARMOR.

HERR V. GRUSON'S chilled iron armor has been now adopted on so large a scale abroad that it is high time that we became acquainted with it in this country. We mean really acquainted, because although we have had it brought occasionally to notice, as, for example, in an able paper read by Capt. Grenfell, R.N., at the Institution of Naval Architects—*vide Engineer*, April 18, 1877—we have no practical experience whatever in connection with it. Even on the supposition that we cannot with advantage employ this armor ourselves, it seems desirable to know something of its



FARCOT'S NEW BALANCE DYNAMOMETER.



ACTION OF SHOT ON WROUGHT IRON PLATE.

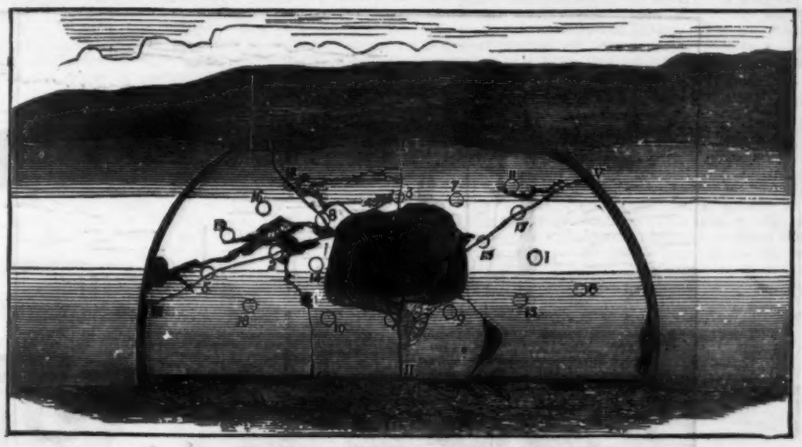
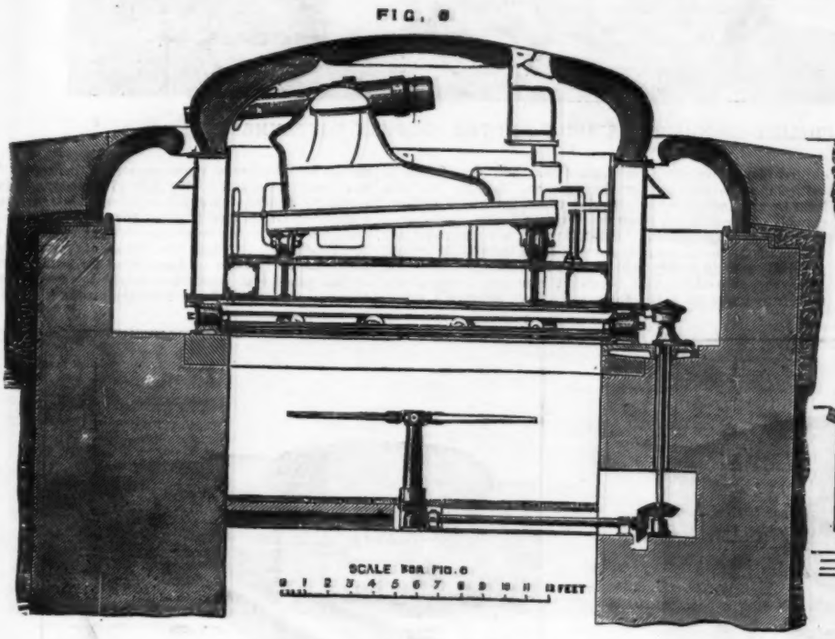


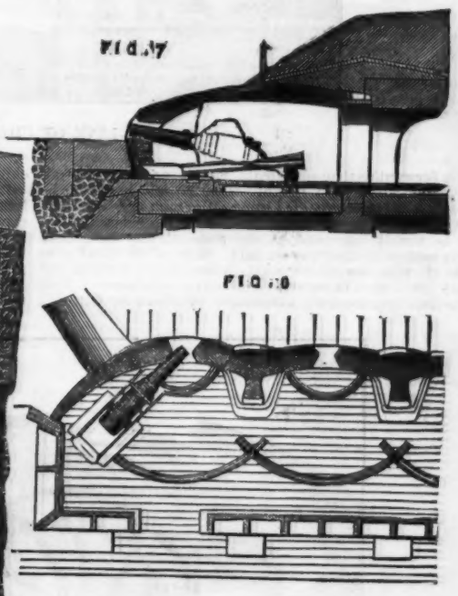
FIG. 5.—EFFECT OF SHOT ON A CAST IRON SHIELD.

behavior, inasmuch as it is this armor that is principally employed in coast forts abroad. France has adopted it for inland defenses on a large scale. We have just heard that an order for 10,000 tons of chilled iron armor has been given. Germany has cupolas and batteries for coast and river defense, as, for example, those on the lower Weser. Belgium has batteries which will be noticed hereafter. Holland has brought to the notice of the authorities by Captain Studer, who has been for several weeks in England. We believe that officers would wish a special trial to be made, and we must hope that no mistaken economy will withhold the necessary funds.

It is not surprising that chilled iron armor, when once it attained to any degree of efficiency, should come in abroad were based and in what measure they have been established by actual experiments. It is urged that the resistance offered by wrought iron armor to shot is on a bad principle. The material is soft and ductile, and its strength consists in its being held together by tenacity rather in any direct power of resistance. Thus a shot enters a soft material, and as it enters its passage is opposed by the difficulty of tearing



SECTION OF REVOLVING CUPOLA.



PLAN OF BATTERY.

voted the money necessary for the erection of cupolas; Denmark has also adopted them. In Spain the Royal Engineers propose the erection of a Gruson turret at the entrance of Cadiz harbor, and in Portugal, Lisbon and the mouth of the Tagus are to be similarly protected. Italy has ordered chilled iron casemates for the Alpine forts, while Russia is about to construct batteries and turrets of chilled armor, especially on the coast of the Black Sea. It seems highly desirable then that we should have some experience as to the behavior of armor which our fleet must expect to find confronting it on any recently fortified coast.

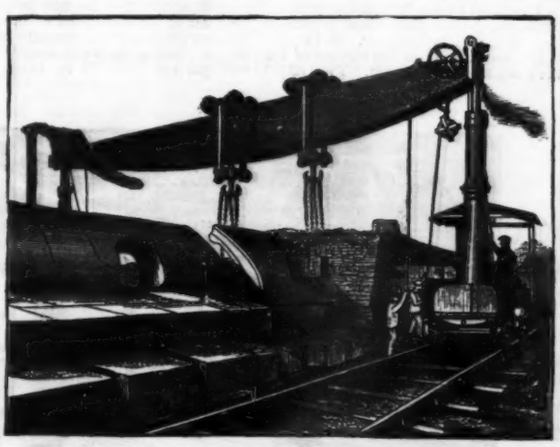


FIG. 9.—MODE OF ERECTING THE CUPOLA.

As to our own country, the matter has recently been before it has attracted much attention in England. We have long since brought wrought iron defenses to a certain degree of perfection. We have experimented on them for many years at enormous expense, and have adopted and applied them extensively. Abroad the manufacture of rolled armor plates is less generally understood, and had only been pushed far n a few establishments. It need not be a matter of surprise, then, that chilled metal, coming forward six or seven years ago as a material easily manufactured and comparatively cheap, should find favor if its efficiency could be established.

Let us see on what grounds its claims for consideration the metal open. This form of resistance is objectionable on two grounds. In the first place it is local in its action—that is, the metal in the immediate spot struck has to bear the entire strain. True, from the same cause the injury effected is local also, and an advantage may be claimed on that account; but this does not affect the objection urged, namely, that the power to keep out the shot must be exerted by the metal in the immediate vicinity of the point of impact. The second objection urged is that the plate only offers resistance in the very act of destruction, and thus any shot that it has kept out has destroyed the armor in the precise measure in which the armor has resisted it. A shot whose power falls far short of that necessary to penetrate the plate impresses all the work it has stored up in it, and penetrates the plate to a corresponding extent, for it experienced no serious resistance on striking the surface, but was stopped gradually as it pushed its way into the plate until it had performed all its quantum of work. This, it is urged, is a very unsatisfactory form of resistance, and it is claimed for chilled iron that it resists the shot at its surface, that its surface does not sensibly yield at all, but transmits the shock into the mass of metal behind it and around it. In this way a projectile must be sufficiently powerful to break the entire plate, or must fail to produce any appreciable effect. The mass of metal, it is urged, absorbs the blow in the same way in which an anvil absorbs the blows of a hammer. The advantage is twofold. In the first place the plate is not sensibly injured by comparatively light blows, and in the second any additional thickness in the armor strengthens chilled metal in a much greater degree than wrought iron. To illustrate this, suppose that Fig. 1 represents the method of yielding of a wrought iron plate during the passage of a shot, a supposition which we know is approximately correct. And suppose Fig. 2 to represent the transmission of a shock through a chilled iron plate, sufficient to destroy it, a supposition which is fanciful, but which may be allowable for purposes of explanation. Then we may see that the portions of plate which come into play and take part in the resistance may be represented by those shown in Figs. 3 and 4, by which it will be seen that if the portion of wrought plate, *a*, be supposed to be equivalent to the portion of chilled plate, *d*, then equal additions to the thickness of the two plates, as shown by *b* and *c* and *e* and *f*, increase the strength of the chilled plate in much greater proportion than to the iron one. This is merely an illustration of our own; we do not

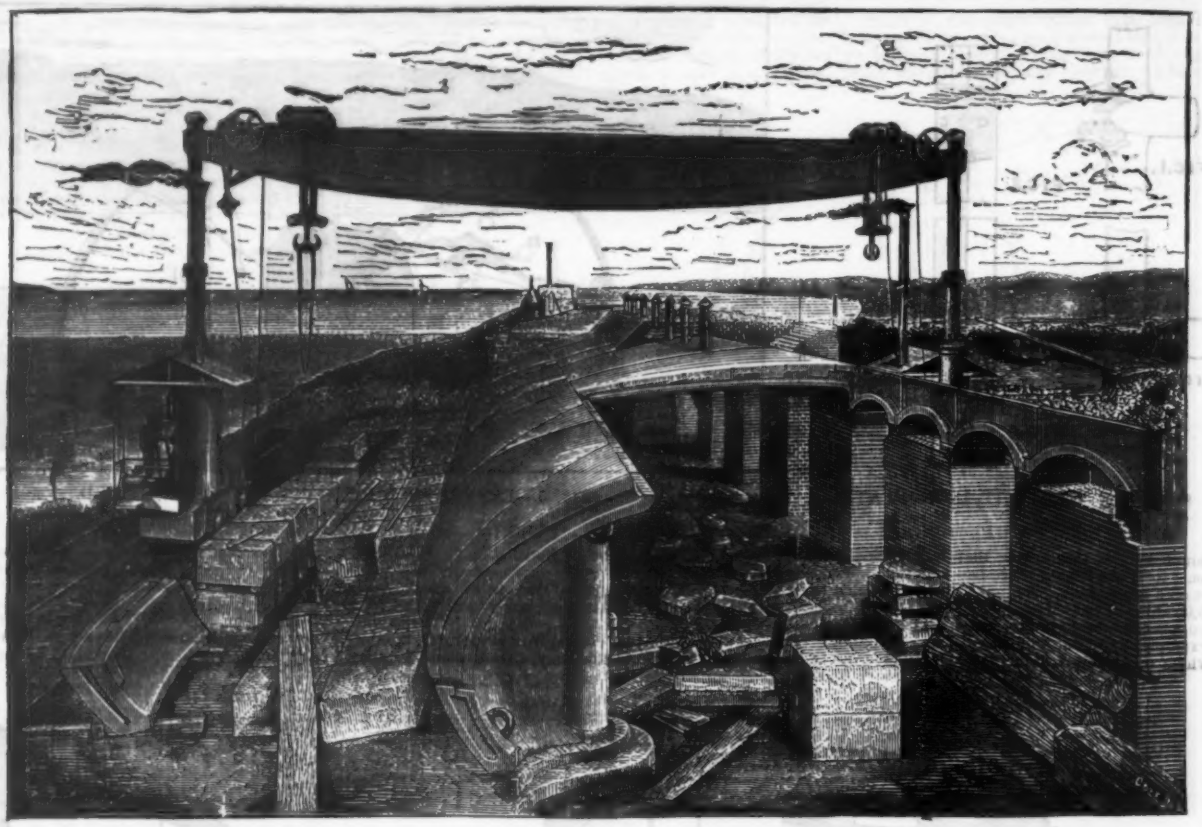


FIG. 10.—LINE OF CHILLED IRON CUPOLAS BUILT FOR THE PRUSSIAN GOVERNMENT.

put it forward as that of Captain Studer or Herr Gruson. We give it to explain roughly what we understand to be advanced in favor of chilled iron. We could urge against it that though the work of a shot which fails to penetrate may not be visibly impressed on the plate, it may have been performed in another way on the particles of the metal so as to do its part toward eventual disintegration without the visible effect seen in wrought iron. We may, however, pass on to less questionable advantages professed by Gruson's armor. It admits of being cast in any desired shape and with any desired variation in the thickness Owing to the difficulty of rolling plates of any but the simplest form, our turrets are cylindrical, the metal of uniform thickness generally, and it is evident that the roof, at all events, may be much more easily protected on Gruson's system. Then, against chilled plates may easily be made in great masses, while in wrought iron the difficulty of manufacture rapidly increases with the thickness and area. From this it follows that chilled plates may often be made near their destination if skilled men are sent out for the purpose. Lastly, but not least by any means, when suffering under the fire of artillery capable of breaking it, there are no bolt heads, rivets, etc., to fly off as langridge in the interior of a turret, and any fragments of metal actually severed from the rest by cracks generally remain firmly held *in situ*, because the cracks are by no means straight, and because the arched form of the structure tends to favor their retention. Gruson's armor when tried at first did not compare favorably with wrought iron, but the Prussian officers even then saw promise of better things when more experience should have been gained, and about 1873, results were obtained which secured its success. Two 517 lb. shot were fired from a 28 centimeter (11 in.) Krupp gun, with an 88 lb. charge, at a plate whose maximum thickness was 28·3 in., at 10 yards distance. Both shot struck on the same place, and formed on the surface of the plate a rough spot a few millimeters in depth. Two slight cracks were observed, commencing on the inside. The shot were broken to atoms. On July 27th, 1874, a trial was commenced. Captain Grenfell says of this trial, which was completed on August 21, that the ten rounds fired against one plate left it far from unserviceable. Firing was then continued, and although the surface of the plate lost in appearance, no increase of damage, as far as the serviceability of the plate was concerned, could be discovered. Three things were remarked: (1) Throughout the whole of the pro-

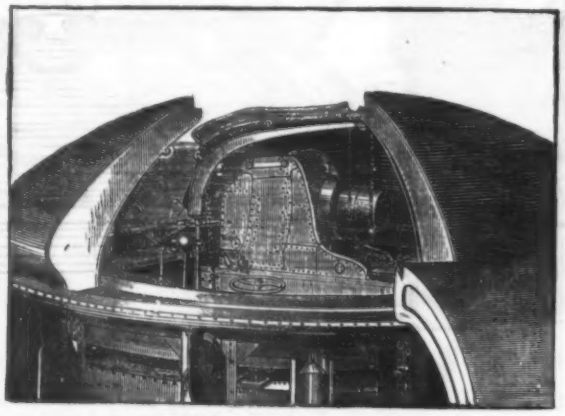


FIG. 11.—ST. MARIE BATTERY, ANTWERP.

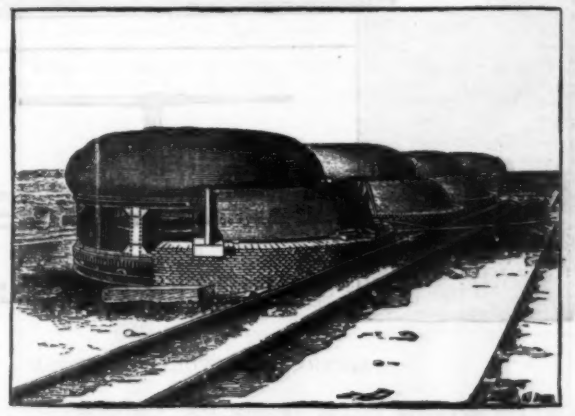


FIG. 12.—ST. MARIE BATTERY, ANTWERP.

tice no penetration into the plate was effected; the projectiles were, in fact, effectually kept out. (2) Even after the plate was split into two parts, many shots were fired without producing any visible effect at all. (3) No injury beyond a crack occurred on the interior of the plate. Fig. 5 exhibits the plate at the conclusion of the trial. The penetration of the shot employed into wrought iron would have been about 15½ in., taking the work stored up at 7,027 foot-tons. A wrought iron plate, 16 in. thick, fairly backed, would pro-

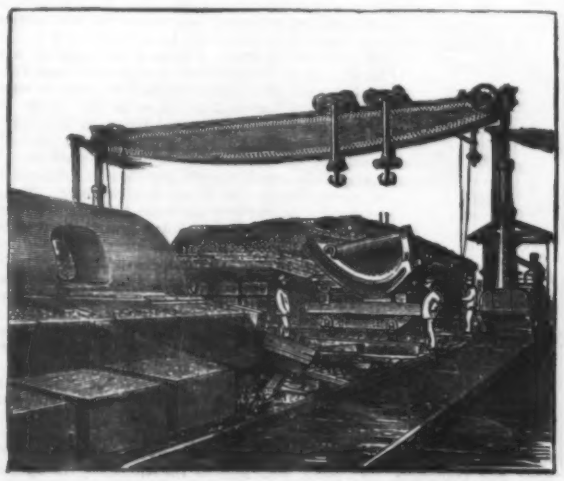


FIG. 13.—ST. MARIE BATTERY, ANTWERP.

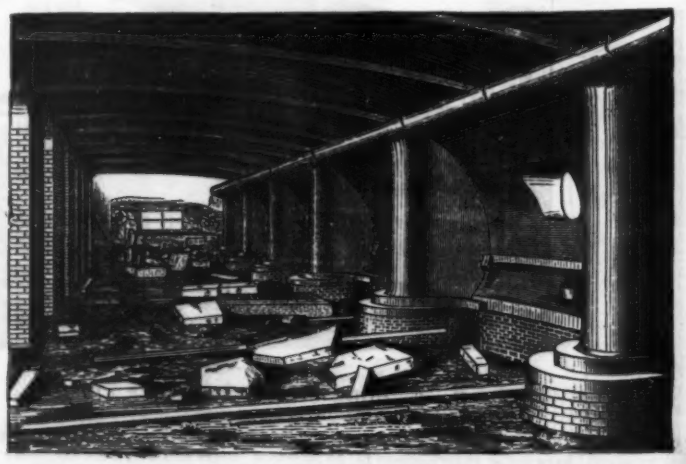


FIG. 14.—INTERIOR OF ST. MARIE BATTERY.

bably have kept any single projectile out; how far it would have stood against nineteen rounds may well be questioned. Speaking generally, then, we see that on this scale of armor the chilled shield, 75 per cent. thicker than the wrought iron shield which would have matched the gun, was able to resist nineteen rounds delivered on a very confined space. Herr Gruson does not expect chilled iron to be a match for wrought iron, inch for inch, on this scale of armor; but for armor for the 100-ton gun the advantage possessed by the former metal as the thickness increases would probably have brought the chilled into the position to rival wrought iron of equal thickness. At Tegel, in the year 1874, a turret, with shield, with a maximum thickness of 55 centimeters (21·65 in.), withstood 277 rounds from a 15-centimeter gun, twenty from a 17-centimeter gun, and two from a 28-centimeter gun. At this period, then, Gruson's metal shields deservedly established their reputation in Germany. The Prussian officers observe that while experiments had been going on with wrought iron in England through long series of years, chilled iron had been so far perfected as to be able to be recommended in three or four years.

As we have said above, Gruson's armor has now been adopted by most of the continental powers. It offers a shield readily made, and very simple in character, requiring no backing or supports, but itself forming the structure required. The iron employed should be of superior quality, free from sulphur and phosphorus, and of course of a selected mixture as to gray and white, so as to combine the required hardness and toughness. The chill should not change suddenly to gray, as is sometimes seen in some superior brands of Swedish iron, but should shade off gradually. The cost is estimated at about £30 per ton. It is thought that the required kind of metal would be readily found in most of our colonies, where iron fortifications are under consideration. Fig. 6 exhibits the general form taken by Gruson's armor in a turret or cupola, as it is termed. In this case the turret is made to revolve by hand, the men working on the levers shown beneath. In some of the earlier examples central pivots were employed; but it is much better to dispense with them. The projectiles and cartridges are lifted from beneath, the guns being in all cases breech loaders. Each turret generally contains two guns. Figs. 7 and 8 exhibit the structure of a battery in section and plan showing the arrangements for training the guns through large angles. The form of the battery is such as to give the armor the advantage of the curve of a cupola as far as practicable. It will be seen that the Gruson form of cupola and battery alike give a great advantage in strength of roof—which can be made strong enough to resist vertical fire. This is an important matter, inasmuch as chilled armor, especially in the cupola form, is likely to be employed in those detached forts which play an important part in detaining an enemy, but which must eventually succumb to a regular attack, without being able in most cases to withdraw the armament or even the men.

Lieut-Col. Kromhout, of the Dutch engineers, has written an able paper advocating the employment of cupolas for these "forts d'arret," as they are termed. He considers that two guns in cupolas may take the place of six in a fort, because it is rarely indeed that six guns directed in diverging lines would be required to fire at the same time, and that two cupolas, by their power to revolve, could probably perform the same work, while they have an advantage in obtaining mutual cover. The saving of four pieces is not merely a matter of economy; it diminishes the prize that may eventually fall into the enemy's hands, not merely by the actual guns, but the corresponding detachments of men and stores. Approaches, bridges, coast defenses, and the detached position about Amsterdam, so Colonel Kromhout thinks, cupolas are specially suited to defend. He calculates that the roof might be made thick enough not only to resist siege pieces, hitherto used for vertical fire, but also a special mortar of Krupp's of 21 centimeters (8·27 in.) caliber, which fires a shell weighing 198 lb., with a velocity of 1,000 ft. per second. Provision would be made for resisting such a projectile, even if its falling velocity were equal to its initial by a roof 15 centimeters (5·9 in.) thick.

To pass from the general question to particular cases, Fig. 9 shows an actual cupola, made to contain a 28-centimeter breech-loading gun, in the course of erection. The segments are lifted by cranes and lowered into their place, after which a mixture of zinc and lead is run in between their joints. This fills up the recessed space seen on the ends of each portion, and gives the entire structure the required solidity, leaving it free, as has been said above, from all liability to langridge, until the entire mass of metal becomes broken up.

Fig. 10 shows a line of cupolas erected for the Prussian government on the principle above described. In Germany there are now at the entrance of the river Weser, near Bremerhafen, the following armor plated works: One fort with five turrets or cupolas, each containing one 28-centimeter gun, and one turret with two guns of 15 centimeters. One fort with three turrets, each containing two 28-centimeter guns, and one turret with two 15-centimeter guns. Also, one battery with nine 21-centimeter guns.

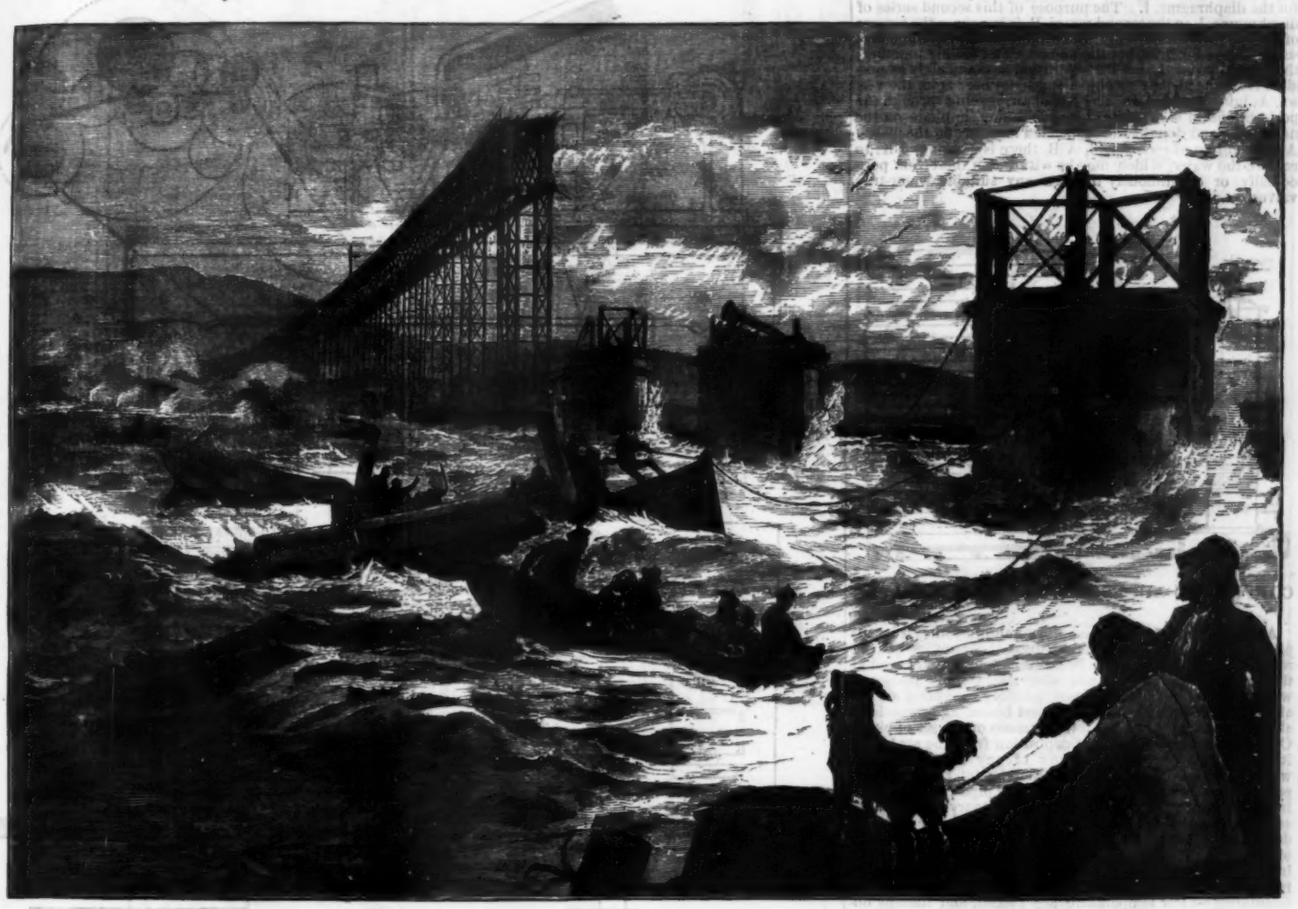
Figs. 11, 12, 13, and 14 show very fully the St. Marie Battery, recently erected for the defense of Antwerp, which place has had special attention bestowed on its protection in the successive stages of the progress of fortification. In Belgium, iron fences have been adopted from their first introduction. One of the first revolving turrets ever constructed stands at Malines. General Brialmont, the chief of the Royal Belgian Engineers, who is well known as an authority on fortification, has advocated the employment of Gruson's armor, although wrought iron had so far found favor as to be previously employed. At Fort Philippe there are now wrought iron turrets which do not appear to give satisfaction. The new St. Marie Battery at Antwerp has Gruson armor of a maximum thickness at portholes of 70 centimeters (27·56 in.), and a minimum thickness of 38 centimeters (14·96 in.); the covering varying from 35 to 20 centimeters (13·78 in. to 7·87 in.) thick. The ammunition is stored under the casemate. The total weight of the battery is 800 tons. A porthole plate weighs 35 tons, a pillar 25 tons, and a covering plate 21·5 tons. These plates were sent to Antwerp by railway in special carriages. A revolving crane was used to put them on board ship, which brought them by the Schelde to the fort. They were then carried and placed in position by means of rails and traveling and steam cranes, as shown in Figs. 11 and 12. Fig. 13 gives a good view of the line of works, and Fig. 14 of the interior.

Officers or others who may visit Antwerp are recommended to apply for an order to see this fort, as there is much less difficulty in obtaining access to such works in Belgium than, perhaps, any continental kingdom. It could probably be done through the British Embassy.

The St. Marie Battery is an illustration of the employment of heavy castings, but we believe that in some instances they have been employed up to 50 tons weight. On the other hand, in the Italian passes it was stipulated that the maximum weight should be 13 tons. We cannot better close this description of the Gruson system of armor than by the expression of a hope that we may see some specimen of it fairly tried in this country.—*The Engineer.*

THE TAY BRIDGE DISASTER.

IN our last SUPPLEMENT we gave a full account of the fall of this great bridge on the evening of Dec. 28, 1879, by which a railway train, with every person on board, was suddenly destroyed. We also presented a number of engravings showing the construction of the bridge. We now give (from the London *Illustrated News*) an additional view, showing the appearance of the bridge near the broken part. Immediately after the accident a vigorous search was instituted for the recovery of the bodies of the drowned passengers, the mails, and other property. Several steam tugs with diving apparatus were made use of. But up to the latest dates little progress had been made in the recovery. The divers found the bottom of the river covered with an almost impenetrable network of twisted and broken iron bars. Nearly one hundred lives were lost. Only a few have been recovered.



THE TAY BRIDGE DISASTER.—SEARCHING FOR THE LOST.

COMPRESSED AIR REFRIGERATING APPARATUS.

By HENRY BELL, JAMES BELL, and JOSEPH JAMES COLEMAN, of Glasgow, Scotland.

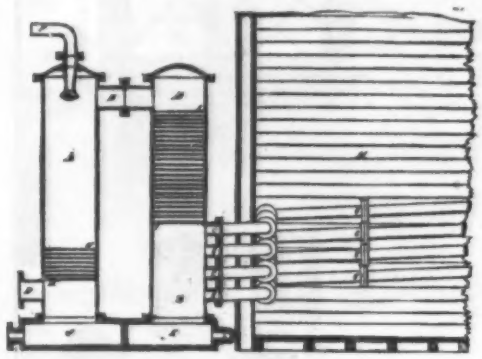
THIS relates to refrigerative apparatus of the kind in which the refrigerant action is produced by compressing air, abstracting heat from the air when compressed, and subsequently allowing it to expand; and our object is to obtain an improved application of this process for the important purpose of preserving meat or other food or beverages. In attempts hitherto made to practically apply the process referred to, difficulties have been met with through the freezing of moisture contained in the air during its expansion, and our improved apparatus is especially designed to avoid such difficulties by means which insure that the proportion of moisture in the air at the time when it expands shall not be sufficient for the formation of ice or frozen particles.

The apparatus is designed for the air to be passed through on its way from the cylinder or cylinders in which it is compressed to the cylinder or cylinders in which it is expanded. The well-known process of cooling the air, while being compressed, by injecting water into the cylinder in which the compression is effected, or by incasing the compressing cylinder in a water jacket, or in both ways, is intended to be used in carrying out our invention, and the use of our apparatus, hereinafter described, is to be additional to, and not instead of, such known process.

The apparatus we employ comprises two vertical cylinders, A B, or vessels of any convenient and suitable form, and a set of pipes, C. The first vessel, A, is formed with an inlet, D, at its lower part for the admission of the compressed air from the compressing cylinders, the air passing upward through this first vessel, A, then across, by a connecting passage, E, to the top of the second vessel, B, in which vessel it descends, and from the lower part of which it passes into the set of pipes, C. At the top of the first vessel, A, there is fitted a pipe, F, for the introduction of wat

of ordinary temperature (or colder, when conveniently obtainable) such water being forced by a pump, so as to overcome the internal pressure of the compressed air. This water injection pipe, F, is fitted with a rose-nozzle, G, for the purpose of dividing the entering water and distributing it over the area of the vessel, A, it being important that the air and water should intermingle intimately while the air passes upward and the water downward.

To insure complete contact and action between the water and air, so that the water may abstract as much as possible of the heat rendered sensible by the compression of the air, the vessel, A, is provided with suitable materials, down through which the water may drip while the air passes upward through the interstices. For this purpose we employ a number of perforated metal diaphragms, H, which are fixed across the lower part of the vessel, A, but above the air-inlet, D, and it is best to arrange these diaphragms with the holes in each opposite the solid metal of the next above and below, in order that the subdivided currents may have their directions continually changed, and be thereby made to impinge upon the wetted surfaces of the diaphragms. Similar diaphragms, I, are fitted in the second vessel, B; or any equivalent arrangement of materials may be substituted for the diaphragms, I. The purpose of this second series of diaphragms, I, in the second vessel, B, is in a sense the reverse of that of the first series, H, in the first vessel, A. The first series, H, are for bringing the air and water closely together; the second series, I, are for separating as completely as possible from the air any moisture it carries over from the vessel, A, into the vessel, B. The jets of air, passing through the perforations in each plate, I, in succession, impinge on the next plate, and deposit the suspended moisture on the plates. At the bottom of each vessel, A B, there is a casing, J K, to receive the water, which may be withdrawn therefrom periodically or continuously through any suitable water-trap valves.



COMPRESSED AIR REFRIGERATING APPARATUS.

Assuming that the water employed and introduced by the pipe, F, is of the ordinary temperature, it cannot, of course, reduce the heat of the air below that temperature, and at this temperature the air will still retain some moisture, which will be precipitated and possibly congealed on the air being subsequently expanded and becoming of considerably lower temperature. It is the purpose of the set of pipes, C, to cause the separation and deposition from the air before it reaches the expansion-cylinder of any moisture which would thus tend to congeal, and thereby interfere with the proper working of the apparatus. These pipes, C, are placed in an atmosphere of a lower than the ordinary temperature, and, being inclined upward from the vessel, B, the moisture deposited in them in consequence of the additional cooling of the air in passing through them drains back from them into the vessel, B. We place the pipes, C, in the chamber, M, in which the meat or other substances to be preserved by maintaining a low temperature are placed, and thereby obtain the required cooler atmosphere in the most convenient and economical manner. The object of passing this compressed air through pipes in the provision-chamber, M, is not for the purpose of cooling the air in this chamber; but, on the contrary, the object is to complete the cooling of the air in its compressed state in these pipes by the cold air of the provision-chamber, and this before this compressed air passes into the expansion cylinder, where its rarefaction produces the required degree of cold.

The pipes, C, should be of considerable length, the precise length in each case depending on the temperature intended to be maintained in the chamber, M, and other circumstances.

Where several chambers, M, are to be kept cool by the same refrigerating apparatus—for example, a number of vans composing a railway-train, or several separate compartments in a ship—the pipes, C, may be arranged in only one compartment of the series.

MACHINE FOR CLEANING WOOL.

An extremely useful machine has been invented by M. Emile Hübner, of Paris, the object of which is to separate from wool, or other textile materials, any foreign materials which may be intermingled with the same, such as fiber of herbs, pieces of grass, or other vegetable substances, etc.

It is most advantageous to treat the wool, etc., in this machine after it has passed through the ordinary carding or combing machines, because the foreign substances have a tendency to resist the action of the combs, and are generally in more or less great quantities retained in the combing machine.

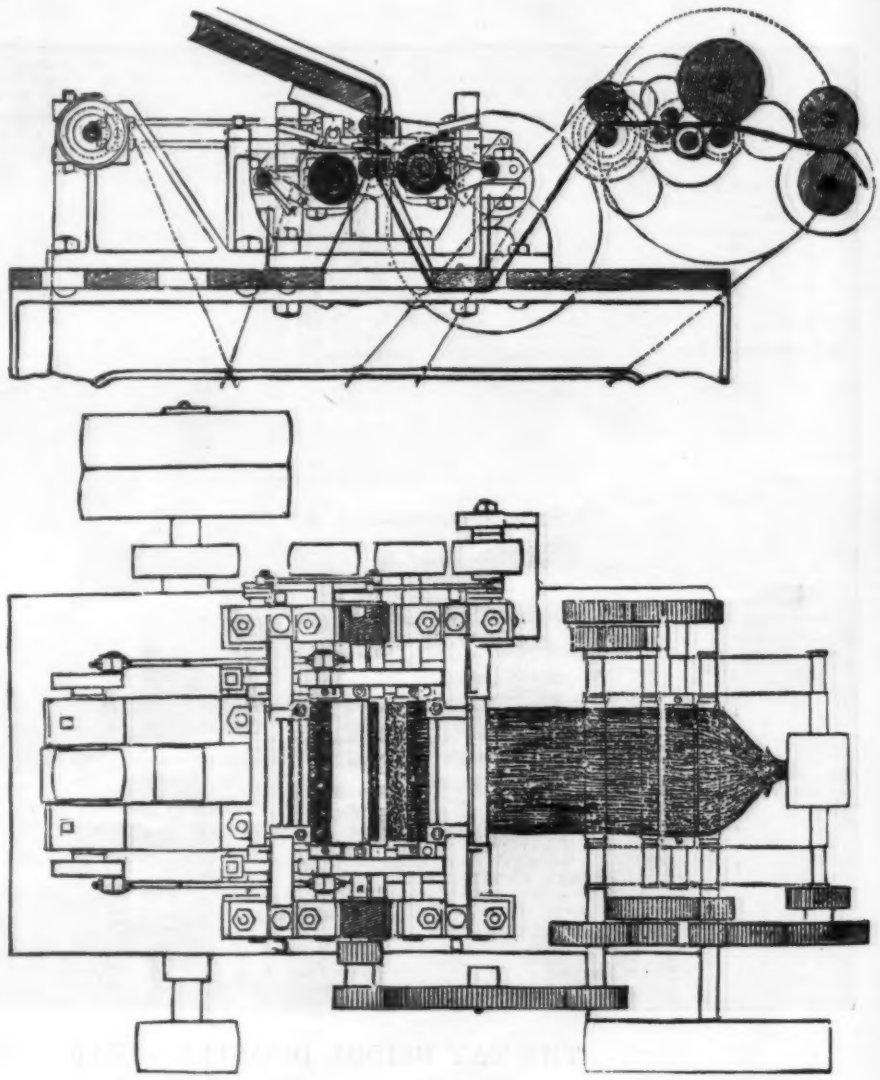
For the purpose of effecting the separation of the extraneous substances from the fiber, a comb is employed, the teeth of which are very fine and closely set, and which is alternately introduced rapidly into the bend or sliver of material to be cleaned, and pulled out again with the same rapidity.

The operation and effect of the new machine is based upon the fact that the fibers of the foreign matter contained in the textile material to be treated are much thicker than the fibers of the material itself. The rapidly reciprocating combs are formed either with one or several rows of very fine teeth, which are set at such distances apart that the space between them permits the fibers of the textile material to pass freely, while, on the contrary, the thicker fibers of the foreign matter become firmly wedged in between the teeth, and can thus be drawn off the sliver.

The accompanying figures from *L'Ingénieur Universel* represent a wool cleaning machine constructed on this principle, combined with an ordinary wool drawing mechanism, which rolls up the clean and picked sliver.

Fig. 1 is a side elevation, and Fig. 2 a plan with the upper feeding cylinders cut away.

A is the main shaft carrying three pulleys, B, C, D. The two circular brushes, E, receive their motion from the pulley, B. The crane shaft, G, is driven from the pulley, C, and the pulley, D, operates on an ordinary wool drawing or rolling mechanism. The latter imparts, by means of an intermediate gear wheel, O, a very slow movement to the two sets of cylinders, H and H^1. The wool or other fibrous material arrives through the trough, P, and passes between these two coupled pairs of cylinders, H and H^1, and during its progress between them the picking and removal of the foreign fibers, particles of straw, etc., takes place. The two combs, K, formed in the shape of hackle bars, are fixed transversely on the two sleeves, J, J, and form therewith a frame which slides on the two rods, Q, Q. This frame receives a rapidly reciprocating movement from the two crank disks, F, on the shaft, G, by means of the two connecting rods, H, H^1. The two combs, K, plunge alternately from both sides into the body of the sliver, receive and hold between their teeth the vegetable fibers and other foreign matters, and remove them from the material. On its return movement each comb comes in contact with and is cleaned by a circular revolving brush, E. A curb comb, R, having a very slow reciprocating movement, rises till it touches the brush, E, which now deposits thereon what it has taken off from the comb, K, and on its downward movement, the full card comb, R, comes in contact with a second stationary card comb, S, which serves to clean the comb, R, and let foreign fibers, straw, etc, fall down into a receptacle. A straight fixed brush, L, is placed over each of the combs, K, at the back end of their stroke, the object of which is to facilitate the drawing of the cords. The slow movement is imparted to the card combs, R, by means of the crank disk, V, and the two converting rods, X, X. The sliver thus cleared is guided towards and passes through the drawing mechanism, Z, which rolls, and transforms it into a round strip of perfect regularity, which may fall into any suitable receptacle, or may be wound up on a bobbin.



MACHINE FOR CLEANING WOOL.

IMPROVED KNEADING AND MIXING MACHINES.

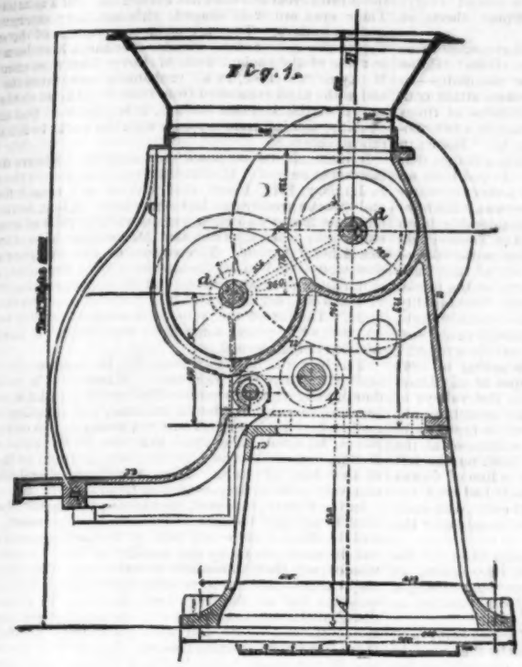
A large demand exists for a special class of machinery required for kneading or mixing materials, such as bread, biscuits, vermicelli paste, etc., as well as for the thorough incorporation of rubber and gutta-percha, colors, printing ink, and a variety of other manufactured articles. Of this class are the machines illustrated on next page, designed, says *Engineering*, by Mr. Paul Pfeiderer, of 87 Farringdon street, London, and which possess several features which appear to be of considerable merit. As will be seen from the illustrations, the machine consists of a set of blades revolving at a high speed within a casing into which the material to be mixed is fed, and of appliances for reversing the motion of the blades with facility. The following are some of the principal characteristics of the machine: The blades or mixers are so arranged as to dispense with the central bosses for securing them on their shafts, and motion is transmitted to them through radial arms, which serve also as fixed scrapers; these arms extend beyond the central line of the axis of the blade, and are adapted in form to suit the required purpose. The clearance for the passage of the material to be mixed may be increased as required by taking out a large portion of the blade on one side of the axis, or two portions on opposite sides, retaining the central bosses of the blades or dispensing with them as desired. Two or more such blades or mixers revolving at different speeds may be employed with a concave bottom having a bridge between them.

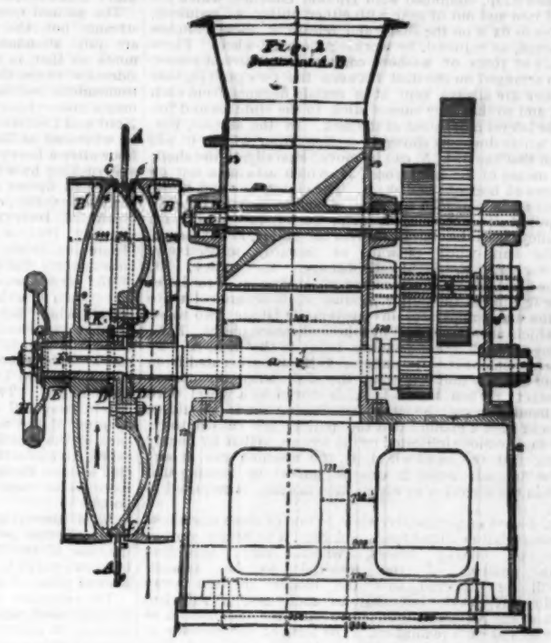
By another arrangement, a number of blades or mixers may be grouped round a common central axis, on which the trough in all its several portions is mounted and made to revolve. The trough in this case forms a kind of drum on the central axis. For the admission and discharge of the material it is provided with one or more openings, which can be closed as required by means of slides, or valves, or otherwise. The trough may be tilted or lowered from the driving gear, or from the blades or mixers, as may be required for emptying or cleaning, without the necessity of having the axis of the driving shaft of the machine coinciding with the axis of the trunnions on which the trough can be turned.

To effect this, either the whole trough or the bottom only in connection with the ends of the trough, are mounted on trunnions, the action of which coincides with that of one of the blades or mixers, or, if preferred, the trough may be taken away entirely.

Figs. 1 and 2 are two sectional views of a machine in which one end and a part of the bottom are mounted on an axis, and can be lowered as shown for the purpose of emptying. In this arrangement one of the compartments is lower than the other, and the blades are actuated by gearing from the shaft, *a*. These blades are driven by and coupled with the driving wheels by means of bushes with square holes in which the pins, *d*, fit. It will be noticed that these pins can be easily withdrawn, and the blades removed without interfering with the gearing. The mode of driving is shown in Fig. 2 by a modification of combined pulleys and clutch.

The arrangement consists in the combination of two loose pulleys on one shaft, one pulley being driven by an open strap, and the other by a crossed strap, with friction or other clutches, by moving which clutches as required, either of the two loose pulleys can be made fast and motion transmitted or reversed with facility and certainty. The clutches are formed of projections, one on each side of a disk, secured on the shaft between the two pulleys, so as to be capable of sliding on the shaft; each of these projections can, by moving the disc on the shaft, be caused to engage with corresponding parts in either pulley, as required. The disk is moved on the shaft, as required by means of a tapped hand-wheel, which also keeps the disk in any required position thereon. For stopping the machine, the hand-wheel has simply to be held fast, while for starting it





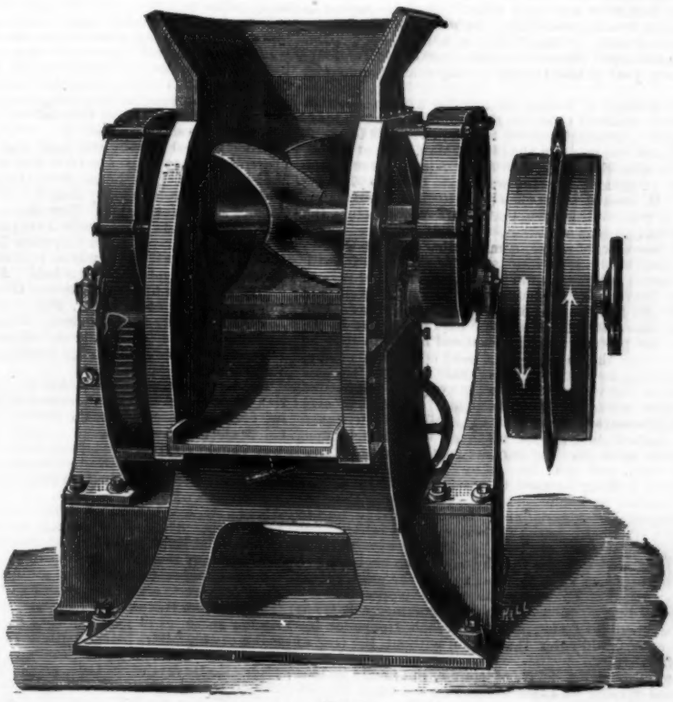


FIG. 3.

FIG. 4.

FIG. 5.

FIG. 6.

FIG. 7.

FIG. 8.

FIG. 9.

FIG. 10.

FIG. 11.

IMPROVED KNEADING AND MIXING MACHINE.

has to be turned in the direction in which the machine is to be worked.

From the foregoing it will be seen that the arrangement consists, essentially, of two loose pulleys with an open and a crossed strap, combined with friction clutches, which are moved into and out of gear with either pulley as required; in order to fix it on the shaft and release it, these clutches are moved, as required, by working the hand-wheel. There is a pair of rings or washers connected by distant-pieces, and so arranged on the disk between the two pulleys, that the latter are always kept at a certain distance from each other, and so that they cannot stick in the clutches and follow the lateral movement of the disk. In the section, Fig. 2, the whole device is shown in section, from which it will be seen that the disk, A, can be moved laterally on the shaft, F, by means of the hand-wheel, H, which acts as a nut on the screwed boss of the disk, A. The clutches, *c* and c^1, are shown cast in one with the disk, A, and by moving the disk as required either the clutch, *c*, can be put in contact with the pulley, B, or the clutch, c^1, with the pulley, B^1, by screwing the hand-wheel outward or inward, respectively. The washer, E, is placed between the pulley, B^1, and the hand-wheel, H, to prevent any movement of the latter by the friction of the pulley against it; G G^1 are collars to keep the whole apparatus in position; D D^1 are two washers which are connected by three distance-pieces, K K, passing through corresponding holes in the disk, A. By this arrangement the two pulleys, B B^1, are prevented from moving laterally and following the disk when thrown out of contact. When the disk, A, is moved by a wheel with right-handed screw, the straps or driving-bands should be put on in such a manner that the pulleys are caused to revolve in directions indicated by the arrows, so that by merely holding fast the hand-wheel, H, the machine can at any time be stopped, while it can be started by turning that wheel in the direction in which the machine is required to work.

Fig. 3 shows a perspective view of one of these machines, of a somewhat modified form, and Figs. 4 to 10 are various forms of mixing blades, which vary according to the nature of the material to be treated. It will be observed that the blades are cut away in different ways, but that in each case a sufficient length of the periphery is left to sweep over the bottom of the trough at each revolution. The form of the recesses, *a*, also varies with the nature of the material to be treated. Fig. 11 is a perspective view showing a simple arrangement of a mixing machine with two blades of the form shown in Fig. 5.

When a very hard or tough material is to be treated, a machine similar to that shown in Figs. 1 and 2 may be used, except that a pair of driving wheels are employed for each blade, one on each side, so as to meet the greater resistance offered. This arrangement of the driving wheels is of special importance for machines with two or more mixing blades on each strap, and it has the further advantage that the shafts may be made smaller, so that they may act as torsional springs to regulate the distribution of power in the two wheels. Such machines may be fitted with a double set of gearing for fast and slow motion.

These machines have already been tested for a variety of work, among which we may mention Messrs. Siemens & Co., for incorporating gutta-percha, Messrs. Peak, Frean, & Co., for biscuits; the Aerated Bread Company; Messrs. Crosse & Blackwell; and Messrs. Savory & Moore, for mixing drugs.

ARTESIAN WELLS AND THE GREAT SAHARA.

By Lieutenant SEATON SCHROEDER, U.S.N.

Of late years public attention has been somewhat drawn to the great North African Desert. Mainly instrumental in directing thither even the eyes and ears of idle curiosity have been the two plans for flooding portions of that region. Of these plans, the French and the English, the former has assumed the more definite shape, though both are the subject of scientific and practical inquiry.

It may be questioned if there is not another means of improvement, more gradual, perhaps, but more sure and in many ways superior to the creation of an inland sea—superior in point of economy, and more widely diffused as well as more lasting benefits. Although our knowledge of the geological and historical part of the Sahara, and of its constitution, hydrography, and climates is scarcely extended enough to prophesy confidently as to its future, yet it may be advanced that, if the desert is extending and the population decreasing, it is greatly due to the bigotry, hostility, and laziness of the Saharan tribes. The one requisite is water, whence the projects of supplying that need from the ocean. Perhaps it may be obtained otherwise, in comparatively homeopathic doses it is true, but fresh, and in such manner as to bring about grander results.

That water is not wanting in the Sahara is proved by the wells dotted along the routes of caravans. These are very shallow, and the water they afford is generally brackish and muddy, showing that they only reached parasitic sources and not the main subterranean sheets; but they are only the hurried work of passing caravans, whose sole thought was to supply the needs of the moment and reach the oases where very old wells have been found having a depth of over two hundred and fifty feet. It is a curious fact, too, well attested, that the number of wells has been greatly reduced by the Saharans filling up many of them as a means of defense against dreaded invasion.

These wells date back to the time of the first relations between the blacks of Soodan and the various peoples of white race driven into the desert by successive invaders. Diodorus, a priest of Tarsus in the fourth century, speaking of the great oasis in the desert forty leagues from the Egyptian frontier, mentions it being irrigated, not by rivers nor by rains, but by springs that issue from the ground not spontaneously, nor in consequence of the rains sinking into the ground, but by great labor on the part of the inhabitants. Several wells alluded to by him have been cleared since 1849 by a French chemist, M. Ayme, who established alum factories in two Egyptian oases. These old wells were fitted with a stone pear-shaped valve by which the issue could be regulated.

About the middle of the sixth century, Olympiodorus of Alexandria speaks of wells five hundred cubits deep. Arabian writers in the middle ages describe them in detail; their great historian, Ibn Khaldoun, speaking of the spouting wells of the Sahara, considers them "a miraculous fact."

The origin of these subterranean waters is now well known. The streams flowing down the southern slopes of the Atlas Mountains of Morocco, Algeria, and Tunis, and on all sides of the Tibesti, Hogar, and other Saharan mountains, quickly disappear through the sands. M. Vivien de Saint-Martin, in "Le Nord de l'Afrique dans l'antiquité," says that, "under the sandy crust through which the waters necessarily sink, layers of clay have been found everywhere at various depths underground, where sheets of water make actual rivers."

The natural question then arises as to what causes these streams; how the parched desert furnishes rivers? Rains are quite abundant on the summits of the mountains—so much so that, in winter especially, the streams attain considerable proportions. The Sahara experiences at times tremendous storms and torrents of rain that in a few moments cause violent freshets. Dr. Barth, in his "Reisen in Nord und Central Afrika," cites among others a deluge that he witnessed at Tintagoda in latitude 19°. In less than an hour after a heavy rainfall on the mountain a sheet of water was rushing by with such force as to carry away herds of cattle and uproot trees, it covered to a considerable depth the whole valley, over a mile broad. In "Les Touaregs du Nord," M. Duveyrier says: "I had occasion on the 30th of January, 1861, while at Oursel, at the foot of the Tasli Mountains, to observe the overflowing of one of the numerous torrents that descend from that mountain. The rapidity of the stream was a meter a second, and the water brought down such alluvia that afterward the Touaregs could sow cereals where before there had been no arable ground." Further on the same traveler says: "In the spring of 1862 a storm of rain falling on the southern slopes of the Ahaggar brought such quantities of water into the valleys of Idjeloudjal and Tarbit that a portion of the mountain was carried away. The action of the water was so rapid as to sweep away and destroy an entire tribe encamped at the opening of the valleys." Also: "Up to 1856, on the left bank of the Ouadi Titersin, there had been a line of downs called Arekka-n-Bodelka so high that camels had been unable to cross them. A freshet in the Ouadi came with such force as to sweep away the entire mass composing the downs."

As M. Duveyrier says, the alluvial deposits from the Saharan torrents are often extremely fertile. At Biskra, at the time of the French occupation of that place (1844), a layer two yards in thickness of a rich loam was found on an ancient pillar of Roman construction.

The existence of subterranean sheets of water being well demonstrated, and a rude example being set by the untaught natives, it only remained to follow that example on the grander scale made possible by the advancement of science, and determine what benefits could be derived from these hidden treasures. Dr. Maurin enunciated, "Dig an artesian well in the region of sands, and the sands will become fixed by vegetation, and a forest of palms will soon stand where there had been a moving plain." And his saying is well borne out by numerous facts. In 1672 an old marabout (Mussulman devotee or saint) dug a well, planted palm trees, and established himself at a place now called Tendouf; in less than a year it had become an important commercial center!

The first attempt at boring an artesian well on Algerian soil was in the plain of Oran, on the 7th of December, 1844. It was fruitless, although carried to a depth of 322 feet. A second attempt was made on the 14th of May, 1845, at Arzeu, and was likewise given up at 580 feet. Some time after the occupation of Biskra, a boring was made there to 270 feet; no result. It seemed a hopeless task to find living water, although it was well known that many years before the Arabs had had artesian wells.

General Desvaux, however, commanding the subdivision of Batna, kept studying assiduously to find means of fertilizing the barren regions around him. The perusal of several works by Tournel, by Berbrugger, by Prax, as well as a memoir of M. Dubocq published in 1853, convinced him that boring was destined to play an important part in the solution of the problem that so occupied him. In 1854 he chanced to be on the summit of a sand hill near his camp, and overlooking the entire oasis of Sidi Rached. He saw that luxuriant vegetation, and turning away was confronted by the sterile waste on the other side. More than ever struck by the contrast, he sent for the sheik and questioned him, and learned that all the northern wells had become filled in with sand, that the parasite waters prevented digging any more, and that the entire population, broken-hearted, were looking forward to leaving their homes. As soon as possible he communicated with Marshal Randon, Governor-General of Algeria, and was authorized by him to commence a systematic search for water in the Sahara.

His project was then twofold: 1. To dig new wells in the Oued Rhir, give new life to the oases then beginning to yield to the invading sterility, and so win the gratitude of their population. 2. To revive the sandy steppes between that river and Biskra, open the desert to commerce as far as Ouargla or possibly Touat, so that French troops or isolated travelers could enter that region without the fear of dying of thirst.

He experienced some delay, of course, but finally in 1856 the material arrived at Tamerna, and on the 1st of May of that year the first blow was struck by Ali-Bey, the Caid of Tuggurt. The work was pushed rapidly forward, and on the 9th of June water issued in volumes. Lieutenant Rose, of the French army, describes the scene as being most affecting, comparing it to the miracle of Moses drawing water from the rock by the touch of his rod; the old sheik prostrates himself, mothers bathe their children in it, and it is blessed and named the Fountain of Peace. The issue of water was 69,725 gallons a day, temperature of 70° Fahr.

The news spread like wildfire, and the commandant of the province of Constantine was besieged with petitions from other oases to do as well by them. In eight years, 1856 to 1864, the French Government established in that vicinity (between the Ziban oases and the river Rhir) seventy-two artesian wells, of which twenty-four had been previously abandoned in the course of execution by the natives. They cost altogether 290,000 francs ($55,970), had an aggregate depth of boring of 11,106 feet, and a total first issue of 17,600 gallons per minute. The deepest was at Chegga, 364 feet; the least depth at which water was found was twenty feet. The ordinary depth was between 160 and 225 feet, and the average temperature 76° Fahr. The largest issue of any was 1,267 gallons a minute from that of Sidi Amran, 255 feet deep. In 1878 there were in Algeria 22,360 meters of wells, yielding 22,000 liters of water a second; their total cost was 2,350,000 francs.

The ground of the Sahara is so impregnated with various salts that the water of these wells, pure at first, becomes temporarily brackish. Analysis made by MM. Ville, Vatonne, and De Marigny show that each liter contained one to three grammes of sulphate of soda, one to two grammes sulphate of lime, besides chloride of soda, various salts of magnesium, and carbonate of lime.

A peculiarity of the wells is that tiny little fish, resembling small whitebait, are brought up in the water. They were first noticed by General Zickel in the water spouting from the well of Aïn-Tala, which is 145 feet deep. The length of these little creatures does not exceed one and a quarter inch. Their eyes are well shaped, although they emerge from regions so dark. They are malacopterygians, of the species *Cyprinodon cyanocaster*. Similar specimens have been found in some of the ancient wells of Egypt that were cleared by M. Ayme; as these, in all probability came from the Nile, and as the sand excavated from those wells is much the same as that of the Algerian borings, it is supposed that in both cases the fish infiltrate through with the water to the subterranean sheets.

It must not be supposed that, once the wells are dug, all labor is at an end. M. Charles Grad, who visited the region in January, 1872, found that several had ceased flowing, and that the greater part had a less issue. A few, on the other hand, he found yielded a greater volume than at first. He studied the matter, as did also M. Ludovic Ville, Directeur des Mines d'Algérie. The causes of the lessening of the flow were found to be the crushing in of the tubes, the accumulation of sand in them, and the increase in the number of the wells, which caused too great a drain on the reservoirs. The life of the wells there without repairs seems to be twenty-five years; some have been known to last eighty without being cleaned.

The lesson to be drawn from this is expressed by the old saying, "Waste not, want not." Wherever it is possible to dam up the running streams of winter and make a reservoir for the summer, it should be done, and artesian borings made where such streams are not available. Among other places, M. Grad maintained that the fertile basin of the Hodna, situated on the Algerian plateau, would be the scene of that kind of work. These dams have already been extensively built in the province of Oran.

In the Sahara, however, the absence of superficial streams renders artesian borings of paramount importance. They will be limited there not only by the underground supply, but in some places by the hostility of the nomadic tribes who oppose their immediate construction. To what extent they can be relied on to reclaim desert land is still an open question, but at the very least they can be permanently distributed along the routes of caravans that penetrate into the southern solitude, and with palm trees planted about them form shady resting places. Up to 1872 one hundred and fifty thousand palms had been planted in the vicinity of the many wells dug in Algeria; in their shade, after the salty ground had been well washed by the flow of water, vegetables and grain were found to thrive. M. Ville, who has made such a special study of the water of the Sahara, announces that, as a rule, a well will water six times as many palms as it gives out liters per minute.

Not a few minds dwelt many years ago upon the possibility of establishing routes across the desert, but that was generally considered chimerical when account was taken of its dangers, known and unknown, the hostility of the races that inhabit it, the length of the marches under a burning sun, over a burning sand, relying upon occasional wells for water, and liable to utter destruction if caught in the path of one of those terrific storms. Still, having a colony on the north coast of the continent and another on the west coast, it is not to be wondered at that the French, with their indisputable energy, should have thought of uniting them overland. More especially does it seem natural in the early days of steam navigation. Nowadays, when cargoes can be sent from Oran to Saint Louis (Senegal) in eight to ten days for eight dollars or less a ton, there is no great reason for sending caravans there, whose best time in a straight line would be three months and a half. Among the enthusiasts on that question may be mentioned General Faidherbe, some time Governor of Senegal, who displayed a wonderful amount of energy in the matter. Others were not wanting, including several explorers; the efforts of the latter, however, were rather more in the interests of science than material benefits.

It was about the year 1850 that the attention of the Algerian Government began to be drawn to the project of facilitating communication across the desert. In 1854 the Geographical Society of Paris offered a special reward for any one who should go from one colony to the other *via* Timbuctoo. In 1858 the Algerian Historical Society made a special order of the day a study on the best route and method of reaching Soodan. Finally, in 1873, a company was formed in Algiers, with a capital of thirty thousand francs, and the rather vague name of "Company for the Encouragement of Commercial Explorations in the Sahara." The intention of this company seemed to be to form at Laghouat an entrepot for merchandise suitable to the southern tribes, and to try to draw to Algeria a part of the traffic of Morocco and Tripoli. The Algerian Historical Society had recommended somewhat similar measures in 1860, but they were not carried out—the cause of the failure being attributed to the lack of French agents outside the Algerian frontier. That indefatigable explorer M. Duveyrier, in 1862, proposed a route following the subterranean course of the Igharghar River southward, different from the four routes generally taken by caravans; the Azdjer chiefs, to whose interest it is to encourage traffic across the desert, offered to guarantee the security of the expedition, and the Algerian Government promised to render it practicable by wells. In 1867 an expedition was actually organized, but was abandoned for reasons not generally known.

Since then the project seems to have been dropped, only to be revived again under a different form. The question of a trans-Saharan railroad has been started, which should not astonish us in America who now think nothing of going from New York to San Francisco in less than a week. M. Paul de Soleillet was among the first to propose the construction of a railroad from Algiers to Timbuctoo, and thence to Saint-Louis; in 1872 he attempted to perform that journey to explore the route, but he got no farther than the oasis of Insalah, about six hundred miles south of Algiers, being stopped by the natives. It would seem that a more practicable route would be found farther east, clear of the Tademayt and Ahaggad plateaux, of which the latter attains an elevation of over four thousand feet. The journeys of Barth and Vogel discovered that, at a short distance south of Tripoli, a series of terraces lead gradually to the vast plains of the desert, where there are only moderate undulations with occasional ravines and isolated masses of rock to Soodan. The southern part of the route was over plains slightly inclined southward. The greatest height observed in that region was six hundred meters.

M. Dupouchel, Ingenieur en chef des Ponts et Chaussées, went in 1877 to examine the ground west of the Ahaggad, and study the practicability of opening a railway between Algeria and the valley of the Niger of Soodan. The results of his examinations have appeared in book form, accompanied with maps and drawings. The route that he recommends commences at Algiers, and passes by Afreville, Be-

ghari, Laghouat, and the oases of Touat, finally striking the Niger at Bamba, a short distance east of Timbuctoo. An eastern branch would descend that river to longitude 2° east, and would run from there toward the Tchad Lake. A western branch would ascend the Niger as far as Kouma, and then run to Saint-Louis. The total length of the line from Algiers to the Niger, deducting the part already constructed to Afreville, would be about 1,700 miles, of which the total cost is estimated at 400,000,000 francs (about $77,000,000). This is $15,000 less per mile than the average of all the railroads built in the United States during the year 1874, and $6',000 less per mile than the cost of the Central Pacific. President Grévy has recently been written to, and urged to appoint a commission to examine a proposal to construct that railroad.

It will readily be seen what an important element in the construction of a railway will be the power to supply water from underground as the work progresses. But there are enthusiasts who maintain that the object now to be accomplished is not simply the establishing of communication across the desert, nor the submerging of one very small portion for the benefit of another small portion, but no more nor less than the reclaiming—the fertilization—of the whole Sahara. This, indeed, sounds rash, and yet no less an authority than Gerhard Rohlfs, who has explored greater areas of Sahara than any other European, and whose journey from Tripoli to Rhadames and Fezzan won him a gold medal from the Royal Geographical Society of London, sustains the idea by saying that nature would soon begin to assist man in the herculean undertaking. According to this traveler, three distinct zones separate the center of the desert from the neighboring lands of the Tchad Lake in the south; in the third or northernmost of these are immense forests of mimosas, where the ground is characterized by the absence of the smallest stone, and which, according to the aborigines, extend from Egypt to Timbuctoo, covering the Kordofan, the Darfoor, the Kamen, and the country of the Touaregs. Professor Rohlfs advances the theory that these forests are encroaching on the desert, and that in time the Sahara will disappear under a vegetation of which the mimosas are the forerunner. "Thus," he adds, "while certain timorous spirits fear that the earth may some day be overpeopled, Nature is silently transforming the soil where man will in the future be able to pitch his tent. The Sahara will be covered with green trees, new lakes will be formed, and the rivers whose dry beds now fill the traveler with horror will be running streams of limpid water as abundant as that of the great streams of Europe."

Such a return to what seems pretty certain to have been the state of things ages ago would be most extraordinary without the help of man. The vast tract comprised between the sixteenth and thirtieth parallels of latitude, and extending from the Atlantic to the valley of the Nile, once fertile, became the arid waste of to-day mainly through neglect. A M. Largeau in 1874 visited the valley of the Igharghar, with the intention of branching off to Rhadames to study the commerce of that oasis and test the practicability of diverting to Algeria the caravans that come there by the central route from Soodan. He questioned the *chambas* on the causes of the drying of the great Saharan streams, and found that all agreed in saying that these dead rivers once ran full through a country more fertile than the Tell (the region north of the Atlas Mountain's crest), but could only explain it by legends more interesting than satisfactory.

M. Largeau gives the following explanation of the change: "It is known that pastoral people have always been great destroyers of forests, for they need large spaces of clear ground to feed the flocks that form their wealth and to promote security against the wild beasts that lurk in forests. Even now the Algerian Arabs are seen firing the woods to enlarge the narrow limits imposed upon them by colonization. So, although the great Saharan streams have not been explored to their sources, yet it is known that they commence on the bare plateaux that are but the skeletons of heights once wooded and fertile. All accounts of the inhabitants of these regions agree on that point. Consequent upon the destruction of the forests the periodical rains were replaced by rare and short though violent storms, the waters from which, instead of soaking in as in past ages, slip by on the rocky masses, carrying away the rich surface mould, and bring about the drying of the springs, and, as a direct consequence, of the rivers."

An admission of this theory leads the way easily and hopefully to the prophecy of Professor Rohlfs, and raises the question whether it would not be better on all accounts to let the salt waters of the Mediterranean circulate in their own proper bed and pursue the more economical work of conquering the desert by assistance from underground. Nearly all the fluvial network of the Algerian Sahara converges toward the Igharghar. Formed by the confluence of several small streams on the slopes of the Ahaggar, it flows northward, and soon sinks through the light sands, and pursues its underground course to the western part of the basin that the French contemplate inundating, bearing in that part of its course the name of Oued Rihr, or river Rihr. Into this same depression flows another subterranean stream, the Oued Djeddi, which has its sources on the plateaux of Laghouat in the west. The two streams in all probability united in past ages, and possibly even connected with the Mediterranean. However that may be, there seems little doubt that water in considerable quantities may be found by boring in the dry beds of these two streams. M. Largeau saw several wells in that of the Igharghar, only twenty-five feet deep, giving very sweet water, of a temperature of 70° Fahr.

With this in consideration, and the example of the marabout of Teadouf still in mind, it would seem possible not only to fertilize large areas of Algerian soil, but to bore our way, as it were, up the slopes of the Ahaggar, and gradually restore the rain-causing forests of M. Largeau, which in their turn might attack the desert from the center, as Professor Rohlfs' mimosas do from the south.

The lowest estimate of the cost of inundating the depressions in the Algerian Sahara being $5,790,000, we see that that sum otherwise appropriated would pay for boring 7,400 wells averaging 154 feet in depth, assuming the cost per foot to be the same as south of the Ziban oases. Allowing the issue to be only one half that of the wells near Biskra, the total flow would be 1,100,000 gallons per minute, which, according to M. Ville, would suffice for the irrigation of about 24,600,000 palms. One tenth of this labor and expense would produce great results.

So far facts and discussion alike have been limited to the region bordering upon Algeria and Tunis. This is because explorations have naturally been carried on there somewhat to the exclusion of the Tripolitan neighborhood, and not because similar causes and effects may not be found further east. There is every reason to believe that the desolate region bordering the south shore of the Mediterranean between the tenth and twenty-fifth meridians is destined to experience an equal improvement with the western Sahara.

The writer of this article, who was one of a party of officers of the United States Navy, engaged in surveying along that coast in 1878, had occasion to observe in several places, notably at Zouaga near Tripoli, and along the shores of the Gulf of Sidra (Syrtis Major), hottest of the hot, and driest of the dry, that water was to be had by digging but a short distance. He noticed, also, not a few oases just on the sandy horizon, that bespoke the presence of the life-giving element. An examination of the map shows many more.

While this would not be very convincing proof to a skeptical mind, in the absence of organized investigation, it may at least be considered encouraging. The day is not far distant, however, when certain knowledge will confirm or disprove hazardous opinions. The various geographical societies of the world have ceased to let the matter rest, and Professor Rohlfs is even now in charge of an expedition sent out by the German African Society. Last January he was two hundred and fifty miles south of Tripoli, at the foot of the Black Mountains; recent advices show him to be at Benghazi, on the eastern shore of the Gulf of Sidra. Accounts of the expedition have not yet come to hand.

In the event of an increase in the commercial importance of Northern Africa, whether by inland seas, artesian wells, or railroads, or all three, means of transportation to and along the seaboard and thence to foreign ports will not be lacking. As early as 1857 a railway system was decided upon for Algeria, which included a shore-line, with branches inland to various points. The construction of this network is practically completed. On the 1st of January, 1879, there were three hundred and thirty miles of railroad in that colony. A line has also been started to connect Constantine with the city of Tunis, the bondholders being guaranteed six per cent. interest by the French Government. This will probably be completed in a year. In Morocco the development of roads is not great; we can not expect very much anyhow from that sultantate, as present laws forbid the exportation of cereals, for fear of a recurrence of the famine. In the province of Tripoli but little is needed now; when the time comes it will be easy work to build a railroad in so flat a country.

In the matter of ports, Algeria points with pardonable pride to Algiers, Oran, Arzeu, Philippeville, Bona, and several minor harbors that have been made secure by artificial works. The first mentioned was begun in 1530 by Bab Aroudj (*Anglicè* Barbarossa) and his Christian slaves, and finished by Christians guiding the labor of that pirate's descendants. Tunis boasts of a magnificent lake at Bizerta, close to the sea; a little dredging in the short, narrow channel leading out would transform it into an unparalleled harbor for ironclads, of which both Germany and Italy are said to be particularly well aware. In Tunis Bay a single inexpensive breakwater, built in only six fathoms depth, would afford perfect shelter. Further south and east, Sphax roadstead only wants ships to fill it, and Surkennis only the Bey's order to welcome foreign vessels to which it is now closed. In the province of Tripoli may be mentioned Tripoli Port, Menelaus Bay in the Gulf of Bombah, Marsa Euharit, Marsa Tebruk, all good natural harbors, or needing but insignificant works to render them secure. In Egypt it is unnecessary to mention the splendid port of Alexandria.

The French are the pioneers in the northern part of the African continent, and it would seem desirable for them to extend their sway to the eastward of Cape Roux. That, however, would cause diplomatic complications; England, Germany, and Italy would surely protest against any projects of annexation. But there is still scope for them in the desert. The nomadic tribes will hardly stop the southward course of empire when French industry and capital fan the breeze of progress.—*Popular Science Monthly.*

IMPROVED FILTER.

ALTHOUGH numerous materials are constantly being recommended as filtering media, and although many methods of circulation and easy cleaning have been adopted, no material has proved better than carbon or charcoal, and by far the easiest method of cleansing is by the process of washing out. The most recent and novel form of filter that has come under our notice, and in which these principles obtain, is the "Filtre Rapide," which is the invention of M. Maignen, of Great Tower street, London, and which is illustrated in the accompanying engravings. It offers particular facilities for cleansing, and at the same time effects the perfect filtration of a large quantity of liquid in a very limited time. A particular and very ingenious principle is made use of in this filter to insure a uniform and fresh layer of filtering material for each usage. The filtering medium, which may be either finely powdered charcoal or pulped paper, is mixed with the liquid which it is desired to filter. The filtering surfaces are formed by canvas drawn over wooden frames. This surface of canvas alone would not be sufficient to filter a liquid; therefore a further filtering medium being mixed with the liquid, is deposited upon the canvas surface, and thereby fills the pores of the material.

Referring to our illustrations, Fig. 1 is a sectional view of

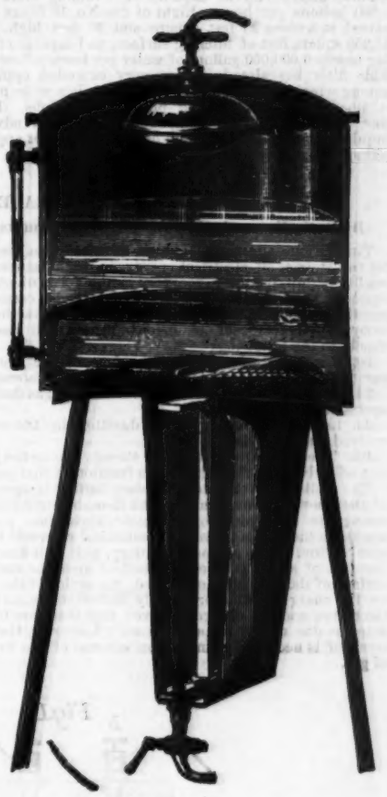


FIG. 1.

one of the smaller filters, suitable for purposes where the quantity required is not more than 40 gallons an hour. By means of a float operating a self-acting admission valve this filter may be made continuous. A false perforated bottom is inserted to form a preliminary strainer by coarse granular charcoal, and to prevent them passing down to the lowest chamber, and also to prevent the liquid from passing to the filtering surface with too much violence. In the deep oblong chamber below is fixed a wooden frame, over which is drawn canvas, forming the filtering surface. This frame is screwed down to the bottom of the lowest chamber by an outside nut, and its interior is in communication with the exit pipe and cock seen at the bottom. The first rush of the liquid through this canvas frame to the exit pipe carries with

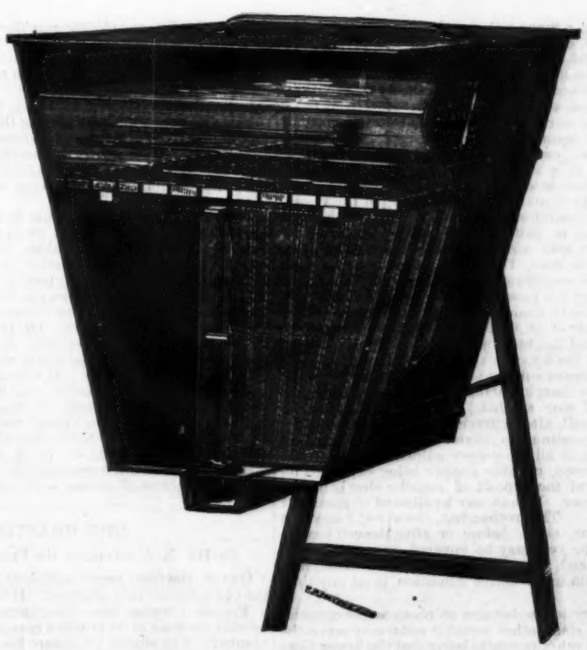


FIG. 2.—IMPROVED FILTER.

it the charcoal or pulped paper held in solution, so that the floating atoms are carried by the current into the pores of the canvas. If the lower portion should be covered first with the charcoal, the current becomes more decided through the uncovered part, and thus almost immediately covers the surface of the canvas with an equal and uniform covering of charcoal or paper pulp. This surface forms an excellent filtering medium, which will last good for eight days of continuous filtering, after which it must be removed, and the refuse material may be used as manure. The cleansing is easily effected, as the entire frame may be taken out and cleansed.

Fig. 2 illustrates the facility with which the surface of these filters may be multiplied in a very small space. The filter, here shown as a half-section, would contain sixteen frames, and would be capable of straining from 400 to 1,500 gallons per hour. Eight of the No. 16 filters can be placed in a room 20 feet square and 20 feet high, having 21,250 square feet of filtering surface, and capable of filtering nearly 6,000,000 gallons of water per twenty-four hours. This filter has already had a very extended application among wine and spirit dealers, but there is a wide field for it among householders and public institutions. Beyond this, we think the water companies might with advantage inquire whether such a system of filtration is not applicable with economy to their requirements.—*Iron.*

A SYSTEM OF ELECTRICAL STORAGE.

By Profs. EDWIN J. HOUSTON and ELIHU THOMSON.

THE various suggestions which have hitherto been made for the storage of electrical energy, in such manner as to readily permit its after recovery in the form of electrical current, have failed when attempted to be carried into practice, either on account of their inherent impracticability, or by reason of the serious inconveniences and losses due chiefly to the following:

1st. The extent of conducting surface of the storage apparatus required to be acted on rendering it cumbrous.

2d. The loss of energy due to evolution of gas during the operation of charging.

3d. Lack of constancy and duration in the currents evolved after charging.

4th. The limited capacity for storage due to the proportion of active material being but a fraction of that present.

The well-known Planté secondary battery is open to all of the above inconveniences, and though admirable in its conception as a piece of scientific apparatus, yet lacks markedly the requisites of an economical reservoir for electrical action. In the secondary battery, as is well known, the duration of action is chiefly dependent upon the amount of surface of the lead pipes employed; the action of the current used to charge it being practically limited to the surfaces of the plates, and the charge received may therefore be designated as due chiefly to polarization. Moreover, the charge received is necessarily limited on account of the evolution of gas.

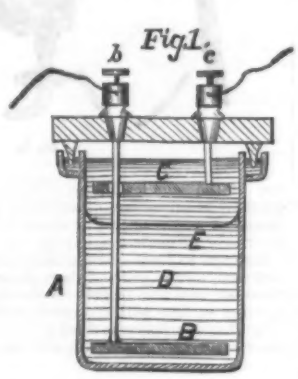


Fig. 1.

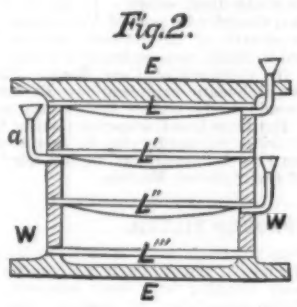


Fig. 2.

It is manifest that a Smee cell, or cell with vertical plates, in an acid solution, could not be used in the process, for the only effect would be the evolution of the gases hydrogen and oxygen from the decomposition of water.

In the system of electrical storage devised by us, the duration of action and consequent capacity for storage is independent of extent of surface and dependent on the mass of material to be acted upon.

In our method we employ a saturated solution of zinc sulphate, inclosed in a suitable vessel, at the bottom of which is placed a plate of copper, to which is connected an insulated conducting wire. At or near the top of the vessel, and immersed in the solution contained therein, is placed a second copper plate, or plate of hard carbon, or metal unchanged by contact with zinc sulphate solution, and less positive than metallic zinc. This is also connected to a wire. The storage cell so constituted is then ready for charging, which is effected by the passage through the cell of a current, whose direction is from the lower to the upper plate. The current employed is that obtained from a dynamo-electric machine, and the result produced is the deposition of metallic zinc on the upper plate, and the formation of a dense solution of copper sulphate overlying the under plate. The duration of the charging action is of course limited only by the amount of zinc sulphate and the thickness of the lower plate. The cell, after charging, constitutes in fact a gravity cell, and continues a source of electrical current until a reconversion of all the copper sulphate into zinc sulphate has been effected, metallic copper being deposited on the lower plate, and the deposit of metallic zinc being removed from the upper. It thus may be allowed to regain its original condition. The recharging, however, may be effected at any time, either before or after the cell has become inactive. The cell may be covered or sealed to prevent evaporation; and since no addition of new material is needed, a restoration to an active condition is at any time possible.

It is not necessary to employ zinc sulphate as the material to be decomposed, since other metallic salts may serve the same end, the only other requisite being that the lower plate shall yield to the solution a metal capable of redeposition, and the solution of which is denser than the solution employed in the cell, and that the upper plate be capable of receiving a metallic deposit and of retaining its form unchanged during prolonged use.

A, Fig. 1, represents a cell of glass, or other suitable material, furnished with two metallic plates, B and C, connected separately by conducting wires to the binding posts, *b* and *c*, the wire from the lower plate being insulated. A porous diaphragm, E, is placed below the upper plate, C, to prevent fragments of deposited zinc from falling on the lower plate, which may occur should the charging current be too intense.

In charging, the arrangement of the cells in multiple arc or in series may be adapted to suit the electromotive force of the dynamo-electric machine employed. The arrangement of the cells in charging may be different from that in discharging, according to the purpose for which the current is designed. Diffusive action of the solutions may be prevented by any of the well-known means used in gravity cells.

It may be objected that the economical results obtained in the storage of electricity as above described will necessarily be low, as but a fraction of the electrical energy in charging will be expended in overcoming counter electromotive force, or in effecting electrolysis, compared with that which overcomes the resistance of the liquid, and therefore lost in heat production. But this objection is readily met by so connecting the cells as to make their counter action or counter electromotive force the chief resistance to its passage. Economical results necessarily follow, the economy attained being measured by the relative cost of the fuel required to drive the dynamo-electric machine and that of the zinc and chemicals used for charging a battery of equal power to that of the storage battery used.

The resistance of the liquid between the plates of a storage cell may be lowered either by broadening the cell or by bringing the plates nearer together. In charging, economical results are obtained by using the plates comparatively near to each other, and separating them during discharge, and thereby avoiding loss by diffusion.

A convenient form of storage battery, designed for rapid charging and discharging, is shown in Fig. 2, where L, L', L'', L''' are horizontal plates of copper separated by insulating rings, W, W, the spaces between the plates, L, L', etc., being filled with a saturated solution of zinc sulphate. Lateral tubes, *a*, are provided to compensate for the expansion of the liquid due to changes of temperature, and also to provide for filling the cells. The cells are held between plates, E, E, by bolts which pass from one to the other. In this arrangement, the plates, L' and L'', serve as upper and lower plates, accumulating copper sulphate on their upper surfaces and receiving metallic zinc on their under surfaces. The series may of course be extended.

When a number of cells are connected in series, several of them may be charging, while the remainder are used as a source of active current.

The most obvious application of a storage battery furnishing a constant and lasting current, is to replace the ordinary telegraphic batteries; the objections to the direct use of the dynamo-electric machine being mainly the necessity for continually sustaining the driving power and preventing variations or intermissions therein; to adapt the current generated to the work to be done; and to sustain a uniform electro-motive force in said current. By the use of a storage battery, the dynamo-electric machine may be run at suitable intervals to produce and sustain the charge of said battery. The economy and convenience of this arrangement will, we believe, be vastly greater than with the ordinary batteries in use.

In lighthouses, a dynamo-electric machine can be run by suitable power at intervals during the day to furnish an unfailing and reliable source of current for lighting purposes.

The purposes for which the storage batteries may be applied are so numerous that mention need not be made of them, the feasibility of each being decided by the question of its economy.

In domestic economy it would be feasible to provide storage batteries to be charged by dynamo-electric machines from convenient central locations, the energy of said batteries to be used in the operation of burglar and fire alarm systems, or for light driving power.

It is practicable in good forms of dynamo-electric machines to realize in external work from 50 to 60 per cent. of the power used in driving them. Of this we believe it possible to store and recover 50 per cent., or even more Therefore 25 per cent. of the original power may be given out secondarily as electrical current. If it be assumed that in the best steam engines it is possible that 20 per cent. of the heat energy of the coal be utilized, then about 5 per cent. of the heat energy might, we think, be recovered after storage as electrical current. Notwithstanding this small per centage, the economy would be much superior to the employment of zinc and other materials used in the ordinary battery in the production of current.—*Franklin Journal.*

SKIN GRAFTING.*

By DR. R. J LEVIS, of the Pennsylvania Hospital.

ONE of the most recent additions to surgical resources is the operation of skin grafting. It is but a few years since a French surgeon first demonstrated the viability of very minute portions of skin when completely excised and transplanted The simple procedure has now received a general appreciation, and found a wide range of usefulness. Its ordinary application is to the surface of chronic ulcers, in which healing in the usual concentric direction is sluggish, or has ceased; and it is applicable also to increase the cicatrization of all largely denuded surfaces by producing centers for eccentric cutification. Besides extending the lines of cicatrizing edges, a physiological influence seems to be exerted, and the surface of an indolent ulcer is stimulated to renewed vital action by the presence of the grafts; even ulcers in which granulations have long ceased seem to be revived by these islands of promise. The utility of skin grafting has, in my observation, been in no instance better shown than in cases of extensive denudation, caused by destruction of the skin, as in burns, and loss of large areas of integument from traumatic injuries. I have seen cases where large sloughs of the integument of the back, due to burns, have healed rapidly under the influence of a few skin grafts. It seems to me very probable that amputation, which, as a final resort in certain cases of extensive ulcers of the leg, is justified, may be substituted by this simple expedient. All of the conditions essential to successful skin grafting I have not, after extended observation, fully determined. The most favorable condition for the development of the grafts is certainly that of healthy, active granulation of an ulcer, and the more nearly this state is approached the greater, as a rule, is the probability of success. It would sometimes seem that the grafts can best be taken from a corresponding portion of the body; thus, in grafting on the scalp, grafts from the scalp of the patient, or of some one else, should be employed. The same rule holds good in regard to the grafts used in plastic operations about the face. The transplanting of hard follicles has, I believed, failed uniformly.

That the influence of grafts in vitalizing the surface of chronic ulcers is very great, may be demonstrated by consecutively repeating the transplantations as the process of granulation becomes sluggish; each graft seems to excite a new healing impulse, as though it were a spur to reparation, and prevents the tendency to relapse into indolence until cicatrization is complete. Indeed, I am inclined to think that by perseverance in skin grafting there are few chronic ulcers, whatever may be their condition, which will not respond under this stimulus.

After extended loss of integument, resulting in disfigurement, deformity, and impaired motion, the beneficial effects of skin grafting are very manifest. Observation would seem to demonstrate that where cutification is rapid, from a number of skin-forming centers, the resulting cicatrix is less violently contractile in its tendencies. Some operators have experienced disappointment in the grafting procedure, on account of the liability of the newly-healed surfaces to a rapidly-destructive ulceration under slight disturbing influences. I have seen a number of illustrations of the susceptible and readily perishable nature of the rapidly-healed spaces; even a general feverish exacerbation that violently affects the patient may cause the delicate cicatrix to dissolve and disappear very rapidly. This delicacy and susceptibility of the newly-formed tissue are merely incidental to its neoplastic character, and the practical lesson to be learned is the careful avoidance of local and constitutional influences that may destroy it. It is not absolutely essential that the surface of the ulcer be prepared for the reception of skin grafts; but the more nearly it is brought to a healthy, granulating condition, the better the chance of success. As to the size and structure of the graft, it should consist merely of the simple structures of cuticle and derma, and should not contain any of the underlying fatty or connective tissues. It is not even essential that the derma be used in its whole thickness, as has been demonstrated by the fact that successful grafting has been effected by using mere scrapings of the cuticle, in which are contained some cells of the superficial or papillary layer of the derma; this method, though, is very uncertain, and has no really practical merit. The graft should never, in diameter or thickness, exceed a fourth or a half line, such being ordinarily the depth of the true skin. The graft should be preferably taken from some portion of the patient's body, and from localities where the derma is thin and not densely covered with cuticle, as on most of the front of the body, and, as a choice, from the inner surface of the arms and thighs. Grafts from other individuals, and even taken from limbs amputated for traumic injuries, develop as readily as when taken from the patient's own body, but the risk of thus transmitting specific diseases forbids such experiments.

The operation may be performed by means of a delicate knife or scissors, cutting off minute particles to use immediately in transplanting, or large pieces may be removed, and these subdivided into suitable sizes for the operation. The skin may be pinched up by means of a small forceps, and the piece snipped off with the curved ophthalmic scissors. The pieces should be about the size of a grain of canary seed or a grain of rice. Dr. Hodgen, of St. Louis, has suggested a method for removing the graft, which is painless, simple, and convenient, and at the same time very effective. It consists in merely penetrating the cuticle with a delicate sewing needle, elevating a small point, and shaving off the minute elevation of cuticle and upper stratum of derma, by means either of a very sharp knife or curved scissors. Blood need hardly ever be drawn in this operation, or, at most, a mere discoloration is perceptible. The graft is then immediately pushed from the point of the needle and placed on the surface of the ulcer, as I now show you, care being taken to keep the epidermic surface upward. No incision should be made into the granulations in order to insert the graft; the blood thus exuded would be liable to elevate the graft from contact with the granulations. As simple adhesion of the graft is all that is desirable, I have sometimes, in cases of large and actively secreting surfaces, allowed them to be exposed to the desiccating influence of the atmosphere, so that the secretions should become viscid and thus hold the grafts securely in position. With the same object in view, I have allowed the ulcerated surfaces to remain uncovered until the grafts became well agglutinated to them. All active medication to the ulcer should be avoided, and the surface merely covered with a light dressing, for protection from disturbing influences. A piece of muslin saturated with carbolized oil or cerate, or a piece of plain waxed paper, is all the dressing necessary. This dressing usually need not be removed for two or three days after the operation, unless secretion is profuse, when a stream of water may be allowed to run over it, sponging and wiping being carefully avoided.

One of the earliest changes noted in the grafts, after the first few days, is the detachment of its cuticle, which may occasionally, by careful observation, be seen floating in the secretions of the ulcer, or by a slight touch it may be detached, leaving the true germinating material fixed in position. The graft, as it commences development as a germinal center, becomes so blended and identified with the granulations as to be for a time almost lost sight of, its reappearance becoming evident in a bluish or lilac-tinted pellicle, which indicates the progress of cutification.

In regard to the size of grafts for transplanting, I have, in a number of instances, grafted by removing from recently

* Reported by Geo. F. Souders, M.D., for the *Medical and Surgical Reporter.*

amputated limbs pieces of skin measuring one-third or one-fourth of an inch square; but such large pieces are very likely to fail in retaining their vitality, and I have found small grafts to give much more satisfactory results. The number and position of the grafts will, of course, vary in accordance with the size of the ulcerated surface, and in large ulcers they may be distributed centrally and near the periphery. Those near the circumference will stretch their granulations outward and stimulate the borders of the ulcer to activity; and, with regard to the advantage of centrally located grafts, it will be well to remember their importance with reference to the difficulty often experienced in eventually healing the last of a chronic ulcer. A large ulcer, on which grafting has been successfully performed, will soon present islets, from which cicatrization progresses in directions of the nearest healing points, until all are joined by an interlacement of newly-formed tissue.

HYGIENE IN THE HIGHER EDUCATION OF WOMEN.

By A. HUGHES BENNETT, M.D.

AMONG the large and increasing flocks of patients who crowd the out-door departments of the metropolitan hospitals, there is a class of persons who of late years have rendered themselves conspicuous by demanding medical assistance. These are women who have to gain their livelihood by the exertion of their intellectual faculties, and who follow callings which require the constant exercise of their mental powers. An example of this is the so-called pupil teacher, whose career we shall endeavor briefly to sketch. A young school girl of about thirteen years of age is remarked to be unusually intelligent. It is suggested to her parents that she should become a teacher. They consenting, the child is at once placed under training. According to information derived from these pupils, the routine of life for the next six or seven years is as follows: They have—1. To continue their education, by receiving from others several hours of special instruction every day, and a considerable proportion of their evenings is spent in preparing themselves for this; 2. They themselves have to teach the younger children in the school for from five to six hours daily; 3. They have to pass a government examination at the end of each year, which entails further special private study. This course of instruction continues for five years; and, being satisfactorily concluded, the pupil becomes an assistant teacher. During the next two years she either resides in a college, and there undergoes a special and systematic course of study, or, if her means preclude, she continues the system already described at school, and further prepares herself for a final examination; after which, if she acquit herself in an efficient manner, she becomes a full teacher, and as such is certified by government.

Such a career may be said to represent the intellectual life of an ordinary student, in which there are considerable mental strain, a constant exertion to acquire and retain knowledge, anxiety as to results, and possibly worry and irritation in details. In consequence, there are diminished exercise, loss of fresh air, and generally deficient hygienic surroundings. We have said that numbers of such young women are constantly applying to the hospitals for medical assistance. They complain of physical debility, anæmia, dyspepsia, and loss of appetite; their functions are disordered and irregular, and they present the usual conditions of bodily weakness and depression. Their nervous system and mental faculties are also affected. They are irritable, nervous, depressed, and melancholic; they do not sleep at night, partially lose their memories, they suffer from violent headaches, and cannot settle to work; they have all kinds of nervous and subjective pains, hysterical symptoms, and, in short, all the phenomena of nervous and mental as well as of physical exhaustion and debility. If our patients be asked the cause of these ailments, they will with one accord say that it is the hard and constant brainwork, combined with worry and perpetual anxiety.

From teachers let us turn for a moment to women who follow other intellectual employments. If we examine the matter we shall find, a certain number of exceptions always being allowed, that as a rule when females are subjected to severe and prolonged mental exertion, more especially if it is associated with anxiety and physical fatigue, they break down under the ordeal. How many excellent and clever women have we known who, either from necessity or from love of study, have eagerly embraced and distinguished themselves in literary, scientific, and educational pursuits! Burning the midnight oil, contending, it may be, with difficulties, harassed with doubt and anxiety, debilitated from want of rest and bodily fatigue, they struggle on, their circumstances or their enthusiasm impelling them, but at last they, like the pupil-teachers, give way and succumb from sheer exhaustion. The objects of this paper are to endeavor to explain why this deterioration of health should so frequently take place in women when subjected to bodily and mental strain, in distinction from men, in whom, under the same circumstances, it is comparatively unusual; and, with the view of elucidating this, to discuss the physical and intellectual capacities of the sexes, and to ascertain whether, in these respects, the male and female are upon an equal footing. That these propositions may be rendered intelligible, some preliminary observations are necessary.

THE PHYSICAL CONFORMATION OF WOMAN.

It will be generally conceded that woman is physically weaker and less powerfully built than man. With few exceptions, this distinction between the sexes is universal throughout the entire animal kingdom. From the lowest to the highest species, the general structure of the male differs from that of the female in the size and strength of his bones and muscles, the form of his head, thorax, and limbs, and in the possession of special weapons of offense and defense. In the human being, although this to a certain extent is modified by circumstances, the same general law holds good. Owing to his conformation, the man is capable of performing and of enduring more physical labor and fatigue, and hence on him, from time immemorial, has fallen the share of manual toil, and of supporting and protecting the other and weaker sex. It is true we sometimes meet with—

"Daughters of the plow, stronger than men,
Huge women blowzed with health, and wind, and rain,
And labor."

Such, all will admit, are exceptions, and by no means represent the standard woman.

The generative organs form a most important distinction between the sexes, and must, to a great extent, modify the habits and career of the female. In the natural course of events, many years of the most vigorous and active period of a woman's life are spent in germinating and suckling her offspring, during which time she is physically capable of little else. If she has not children, frequently recurring periodic processes take place, which, under the best circumstances, render her specially liable to derangement of her general health, and under adverse conditions she is almost certain to fall a victim. This was demonstrated in the days of slavery, when the owners, either not knowing or caring about these physiological laws, forced their women to labor continuously in the fields, in consequence of which thousands of them died of those numerous ills to which female flesh is heir. We can not here enter at length into this very important subject, but merely indicate that the whole sexual system of woman has a profound influence on her physical nature, which does not exist to the same extent in man, and, although for conventional reasons such questions are usually suppressed in public controversies on the advancement of her sex, there can be no doubt that they should not be forgotten, having, as they do, a most important and practical influence on the subject.

From these considerations the conclusion may be drawn that woman is structurally less powerful and vigorous than man, that she is less capable of performing acts of physical exertion, of enduring fatigue and exposure, and of combating against adverse circumstances. That, moreover, the natural functions of her sex, when they do not actually incapacitate her from action, render her specially liable, under disturbing conditions, to deterioration of general health.

THE NERVOUS CONFORMATION OF WOMAN.

The whole nervous system, in common with the other structures of the body, is smaller and less voluminous in the female than in the male. Its function is characterized by comparative weakness, as evidenced by great susceptibility and instability, and also by promptness in responding to all kinds of stimuli. In women there is less nervous capacity and vigor, diminished power of control, and a greater readiness to break down under physical and mental strain. It is notorious that the conditions termed nervous and hysterical are almost entirely confined to the female sex, in which they are extremely common. Every physician at a hospital who treats out-door patients knows that for every hundred men he prescribes for he is called upon to treat at least five hundred women. On the other hand, the male wards are always full, while many of the female beds may be vacant. This simply indicates that serious disease is most common in men, while trifling nervous ailments are almost universal in woman. Most women are naturally so predisposed that, when subjected to fright, grief, anxiety, pain, and other such circumstances, they feel (in addition to the direct distressing effects) various remote subjective phenomena in the form of suffocations, spasms, bodily pains, fainting, convulsions, and a general liability to violent and explosive emotional demonstrations. If the causes are permanent their effects may become so, and deteriorate the general health, and there are thousands of women who are hopeless invalids, often for life, from conditions acting on their susceptible and mobile nervous systems, which in the other sex would have produced no appreciable results. There are, of course, in this as in other things, numerous exceptions to the general rule, many women having their natures much modified and approaching the male type, and in the same way there are some men who are of a nervous and hysterical temperament. We may, then, assert as a fact that the nervous system of the average woman is more susceptible and impressionable than that of the average man, that it is in consequence more readily unhinged by mental and physical distress or fatigue, and that when thus disordered it reacts upon the system, so as to cause permanent disease.

THE INTELLECTUAL CONFORMATION OF WOMAN.

The cranium of woman is smaller than that of man. The weight of the average female brain has been estimated at from five to six ounces less than that of the average male brain, and a general inferiority in size exists at every period of life, from the new-born infant to old age. Not only has this comparative decrease in size been determined, but it has been ascertained that the female brain is relatively smaller than that of the male, as compared to the weight of her body, and researches on this subject have shown that, while the encephalon of the female is ten per cent. less in weight than that of the male, her total bodily weight is only eight per cent. less. The brains of different races vary greatly in size, but whether it be in the most highly civilized nations, or in the lowest savages, the encephalon of the female is always comparatively and relatively smaller than that of the male. These facts show that the difference in size and weight is obviously a fundamental sexual distinction, and not one which can be explained on the hypothesis that the educational advantages enjoyed either by the individual man or by the male sex generally, operating through a long series of generations, have stimulated the growth of the brain in one sex more than in the other. All other circumstances being alike, the size of the brain appears to bear a general relation to the mental power of the individual. There are doubtless exceptions to this rule, but unquestionably the general axiom holds good in large averages; therefore, as the organ of intellect in the female is smaller and lighter than that in the male, we may fairly assume that it is less capable of such high and extended mental powers. It is justly stated that quality as well as quantity should be considered, but of this we can only judge by results, in which case it must also be conceded that women are at a disadvantage. This assumption, if it cannot be anatomically demonstrated, is amply proved by facts. From the beginning of the world, as man has been characterized by his physical force as compared to woman, so has he been remarkable for his superiority of intellectual power. At every age, in every country and climate, and under every circumstance, we find that in the highest qualities of mind, of reason, judgment, genius, inventive power, capacity for acquiring and utilizing knowledge, man stands pre-eminent. It is true that there have been some noble and illustrious women who have proved themselves of the highest mental capacity, and who have risen to the first rank in various departments of intellectual culture, but it must be admitted that these are rare exceptions, and that even they in every particular have been enormously outnumbered and surpassed by men. It may then be reasoned that the female has hitherto not had the opportunities or education necessary to fit her to place herself on an equality with the other sex. This argument of itself proves that she has not been born with the mental force to assert her pretensions, for it cannot be maintained that physical strength alone could have forced her into a secondary intellectual position. Besides, it is not so for in literature, poetry, music, art, and in numerous other branches of study in which she has had as many if not more opportunities of perfecting herself than man, she has rarely proved his equal and never his superior.

The intellectual powers of woman not only differ in degree from those of man but also in character. Her mind participates with her physical constitution in being endowed with great sensibility, and hence her acuteness, perception, and tact. She seizes with rapidity objects which come before her, and observes by instinct an infinity of shades of meaning in details which might escape the most observant of men. She often arrives at conclusions with great celerity and adroitness, but then her results are as frequently wrong as right. Her perception is fine and penetrating rather than extended or profound. She readily occupies herself with small impressions and details, but is arrested there, being less capable of grasping general principles. Although her mind may thus embrace a variety of particulars, it is to little practical purpose, from an intellectual point of view, as she cannot fix her attention on any idea or train of ideas for any length of time, and reason out a logical conclusion. Woman dislikes and avoids that hard work which requires long and profound meditation, her character being adverse to the study of abstract science. Her thoughts wander, she becomes impatient, and her too mobile imagination is unable to rivet the attention on the dry details of a practical subject. She enters with enthusiasm and often with unnecessary vigor at first into any new project, philanthropic, educational, or otherwise, but rarely carries it steadily out to a successful termination. Her opinions are formed by her feelings rather than by the operations of reason. Her forte is that species of knowledge which requires more tact than science, more vivacity than force, more imagination than judgment. Her chief moral philosophy is directed to the study of individuals and society, and the sagacity of a woman in acquiring traits of character and penetrating true motive is what the logic of a man rarely acquires. Wise women—the so-called blue-stocking—as a rule know nothing profoundly. Their natural acuteness of perception enables them to seize a number of details and isolated particulars; they fancy they understand them thoroughly; they confound theory with fact; the real difficulties they do not surmount, they cannot fix the attention long and deeply, or persevere in overcoming obstructions, and they feel no pleasure in habits of profound meditation. They therefore remain with their acquired superficial knowledge, pass rapidly from one thing to another, and there only rest in their minds certain crude and incomplete notions, with which they are quite satisfied, and of which they make the most, but which in consequence lead to false and illogical conclusions.

These observations are not for the purpose of merely lauding one sex at the expense of the other, but for a definite practical object, as will subsequently be seen. They serve to indicate that the average woman has been by nature endowed with a brain and nervous system of inferior anatomical construction to that of man, and that in consequence her intellectual powers differ from his, both in degree and in character.

THE DISPOSITION OF WOMAN.

Voltaire has said, "le physique gouverne toujours le morale," which is strikingly illustrated by the present inquiry. In the lower animals there is a marked difference in the disposition and character of the sexes. The males are of a combative nature, and have a great tendency to fight. They are bolder, fiercer, and more untamable. The females have more highly exalted perceptive faculties, they are cautious, artful, and cunning, as is abundantly seen in the ingenious methods they adopt in the hiding and protecting of their young. These properties serve them to some extent in lieu of physical force, and they are altogether more gentle and more tractable in their nature. The same, in a different degree, is obvious in the human female. Every mother knows that a male infant is more troublesome to rear than a female. As children grow older the difference becomes more marked. The girl is less boisterous, willful, and imperious than the boy. She is more delicate, impressionable, and artful, pleased with attention, solicits admiration, and is readily moved to tears at suggestion of sorrow or pain. He courts danger, is bored with solicitude, and, more blunted or careless, laughs at what she weeps at. She, with her doll, already anticipates the gentle duties of maternity. He, with his sword and trumpet, mimics the glory of war. On the disposition of the fully-developed woman poets have written volumes. We, however, have to take a more matter-of-fact view of her than they have done. When Hamlet said, "Frailty, thy name is woman," he was scientifically correct, in more senses than he intended. Her natural muscular feebleness and delicacy of constitution render violent exercise and labor distasteful to her, and her inferiority of intellectual power makes severe and constant mental exertion a task. While the man, full of bodily and mental vigor, goes forth seeking and braving danger and labor, proud in the responsibility of those dependent on him, the woman fulfills a welcome task at home in the less active duties of matrimony, and of domestic and social observances, equally happy in the possession of a strong arm and head to protect and support her. Such an existence, however, fosters a great susceptibility of character in addition to her natural conformation. Hers is often a mixture of extreme happiness or of profound misery. She feels pain, grief, and anxiety acutely. To these she readily gives way, and as rapidly revives from their effects. Sensations of all kinds act on her powerfully. These she cannot control, but exaggerates into extremes, and manifests by violent demonstrations. If she feels acutely it is not for long, her sentiments at the time being easily replaced by new ones, and her mental distress, if rapidly induced, is more poignant than deep. Woman is essentially impulsive and emotional; her sensitive and changeable nature is necessary for the part she has to play in life. She feels more than she thinks. A man forces his way by power of body and intelligence. She acts on him by tact and by all those weaknesses in which with him lies her chief power. Her flexibility of character gives rise to caprice, which consists of a brusque passage from one sentiment to another totally opposed. Her habitual feebleness and deficient vigor inspire her with less confidence; and, as a woman cannot, therefore, act directly, she employs indirect measures to effect her ends. Hence the natural desire to please inherent in the sex, the artfulness, the dissimulations, the little managements and intrigues, the graces, the coquetry, and other seductive ways, which, to a certain extent, have always been ceded to by intellectual and physical force. For the same reasons, and from the same cause, her weaknesses and vices are greater, and no man can compete with a really bad woman in petty jealousies, spiteful actions, revenge, and even in the ingenuity and vindictiveness of crime. It is this affectability which, if it be a cause of her frailties, is equally efficacious in giving luster to her virtues. It is this which constitutes the chief charm of the mother, who instinctively detects the slightest desire or change in her offspring and impulsively acts for its benefit; of the wife, who sympathizes with and

encourages her husband, fagged and anxious for the common weal; and of the nurse, who takes in at a glance all the details and wants of the patient and ministers to his requirements with pity and devotion. It is this which gives rise to that compassion, sympathy, piety, and affectionate disposition which are the chief characteristics of a woman. It is the feeling of powerlessness which makes her identify herself with the unfortunate and unhappy, which natural pity is the base of all social virtues.

THE EFFECTS OF SOCIAL LIFE AND EDUCATION ON WOMAN.

There can be little doubt that social manners, education, and an infinity of circumstances may affect the qualities woman derives from her material organization, and even efface the original character which nature has given her. In the simplest condition, the man labors with his hands and with his wits for mutual support and protection, the woman rears her children, tends the sick, and conducts domestic affairs. Such, if the most primitive, is probably the healthiest and happiest condition for the female. Her sympathetic and susceptible nature has here every scope for action without being shaken by rude and oft-repeated shocks. In civilized life, especially among the upper classes, everything seems combined to foster and increase the natural affectability of woman's nature, and society renders her, already unfortunate by organization, the victim of the most painful and varied series of moral and corporeal affections. Medical philosophers have declaimed, and will long continue to do so, in vain, against the whole system of the education and bringing up of women, which is directed solely to the purpose of making them personally attractive, and subsequently securing for them brilliant settlements for life, at the expense of their health. Much might be written on this subject; suffice it at present to state that the useless and insipid lives that most young ladies lead, the total want of an intelligent interest and occupation, and the unnatural and artificial existence pursued, are highly calculated to injuriously enhance that natural affectability with which she has been endowed. The system of fashionable boarding schools, whose anxiety to render their pupils accomplished and fascinating at all costs results in a forced and at the same time imperfect training, combined with luxurious living, absence of exercise, and other healthy circumstances, tends to increase the irritability of the nervous system and to foster a precocious evolution of character. As this is increased, tone and energy are diminished. The girl returns from school a wayward, capricious, and hysterical young lady, weak and unstable in mind, habits, and pursuits. She enters into society, and there her whole mode of life further contributes to her unfortunate condition. The competitions, disappointed affection and vanity, the artificial excitements of balls, public entertainments, late hours, and all the frivolities and pleasures of fashion, tend in the same direction. The cultivation of music, poetry, novels, and other inflammatory literature nourish illusions contrary to the actual state of society. Her very dress seems made on purpose to interfere with the healthy function of her most vital organs, and to prevent the free play of muscular action essential to a sound constitution. Girls subjected to such a *régime*, when their minds and bodies should be guided in a totally opposite direction, have one order of faculties alone exercised, and these, predominating over the reasoning powers, cause a host of nervous, vaporous, hysterical, and hypochondriacal disorders. Thus women from their earliest days are constantly subjected to the yoke of prejudices, are under the necessity of a perpetual state of acting and deception, of dissembling their desires and real inclinations for the sake of propriety, of keeping to themselves the most powerful passions and the strongest propensities, and of feigning a calmness and indifference when they are devoured by a burning fire.

As to education, we have already pointed out the general unsatisfactory nature of the intellectual studies of most women. That idleness and the absence of suitable and substantial occupation for the mind which so commonly exists in the higher ranks of society are the sources of great evils no one will deny. For the frivolous and luxurious so-called duties of fashionable life, although exhausting and fatiguing, cannot be said to constitute that healthy exercise of mind or body which is desirable for young women to stave off disease and maintain sound health. Study and occupation, at the same time positive, useful, and attractive, are the best correctives of an imagination ardent and disordered, of a nervous system susceptible and hypersensitive. These considerations being made patent, many women, with the impulse characteristic of their sex, have rushed to the opposite extreme. They wish females to receive the same education as males, and to compete with them in the intellectual struggle for existence. We have, however, seen that both the woman's body and mind are inferior in vigor and power to those of the man, and, accordingly, if pitted against one another in a physical or mental race, she, to use a sporting phrase, would be heavily handicapped. She will not, as a rule, reach his standard, and, if she endeavors to do so, it will be at the expense of her health. The brain and nervous system, like other organs, if overworked, become the centers of activity, and are fatigued; this increases existing susceptibility, and hence arise symptoms of nervousness, hysteria, hypochondriasis, and insanity. These acting on the body produce emaciation and other diseases, the offspring of an exhausted constitution.

The conclusion, then, to be drawn from this section is that, in addition to the natural affectability of her character, this condition in woman is fostered and augmented by the artificial exigencies of civilized life; that, whereas idleness and want of occupation are the greatest sources of many diseases peculiar to the sex, the opposite extreme of mental strain is equally prejudicial.

We have endeavored, in the brief space allotted us, to point out the physical and intellectual capacities of woman, and in consequence the disposition and instincts which nature has implanted in her. This fundamental difference between the sexes, we have seen, is not due to education or special cultivation, but to a primary development of the system, each having those peculiarities best fitted for the part it has been born to fulfill. There can therefore be but little doubt that the most natural and healthy condition for a woman is a properly assorted marriage, in which she has children, with whom she has useful and congenial occupation, and by whom all her sympathies and best instincts are developed. In modern times great and laudable efforts are being made to effect an improvement in the higher education of women, and, as there are many who either from choice or circumstances cannot occupy that position which it is the pride of most to possess, a movement has been made whereby they may earn an independent livelihood by the exercise of their mental faculties. We are informed by energetic and doubtless well-meaning speakers from the platform, that women have hitherto been under subjection, that they should emancipate themselves, that their intellect is as good as if not better than that of men, and that they are as capable as men are of the highest mental culture, and of profiting and distinguishing themselves thereby. It is unquestionable that suitable occupation and education are of the highest importance to the well-being of women, and that all due encouragement should be given to those who endeavor to provide for them an intelligent interest in life. But in avoiding Scylla care must be taken not to drift into Charybdis. To say that the majority of women are fit to cope successfully with men in the intellectual world would, we believe for the preceding reasons, be a most injurious doctrine, and lead to disastrous results. Our text, the pupil-teacher, is an example. A young girl, between the ages of fourteen and twenty-one, the most anxious and important period in her whole life, when her mental and physical constitution is undergoing development, is put under a severe intellectual strain. She is irritated and worried all day by teaching children, she is fatigued by hard study, and is rendered constantly anxious by the frequently recurring examinations on which her reputation, and it may be her living, depends. Such a career does not as a rule break down the young man, but in a large number of cases it completely unhinges the woman. She, in fact, is compelled to perform the work of a man without having his organic basis to depend on, and hence, as a consequence, her entire system suffers. So it is with women who follow other pursuits requiring severe mental application; they age before their time and finally succumb. It is true that men occasionally give way under the same ordeal, but these are comparatively the exception, and this is as often brought about by the assistance of other circumstances as by work alone. It is also a fact that there are some women who, overcoming all difficulties, have fully acquitted themselves of the highest mental exertions without injury, thus proving themselves to be of masculine capacity. Whether for these the church, the bar, and physic are to throw open their arms, I leave for others to decide; but that the majority of the sex would be benefited by a systematic encouragement to follow learned professions and other laborious callings, would be, we think, physiologically and practically an error.

How unmarried women who require to earn their living are to do so by the exercise of their intellectual faculties, is one of the great problems of the day, and by far too extensive a subject to discuss at present. Our aim has been to point out that in controversies on the question the medical aspect of the case is frequently lost sight of, and it is forgotten that, in the competition for life, woman is the weaker vessel, and liable to be broken when too roughly handled. Sage philosophers may speculate what ages may effect by evolution, but, taking woman as we find her, we believe that her welfare is to be consulted, not by encouraging her to take an independent position in life and by fostering a contempt for marriage, which is now the professed tendency of the strong-minded young lady, but by educating her in such a judicious and sensible a manner as will make her a good wife, mother, and usefel member of society, which is unfortunately not the inclination of the present age. If this were more systematically carried out, there would be fewer single women under the necessity of working for their own living; the outcry in behalf of these unappropriated blessings would be modified, and on entering the marriage state, which is the happiest as well as the healthiest condition, they would place themselves in the position that it is intended by nature they should occupy.

". . . . Seeing either sex alone
Is half itself, and in true marriage lies
Nor equal, nor unequal; each fulfills
Defect in each, and always thought in thought,
Purpose in purpose, will in will, they grow,
The single pure and perfect animal,
The two-celled heart beating with one full stroke
Life."
—*Sanitary Record.*

ASPHYXIA.—A "SPEEDY METHOD."

By HARVEY L. BYRD, M.D., etc., Baltimore, Md.

IT is hardly necessary in an article like this to urge professional attention to the vast importance, in a medico-legal point of view, of establishing, even for a moment or two, the vitally necessary function of respiration in the newly-born infant. And whether a child be considered a "living soul" or not ere breathing occurs, all will agree that humanity calls loudly for prompt and efficient action at the hand of the officiating accoucheur for the development of the respiratory process in all cases where children emerge into the world in an asphyxiated condition.

Asphyxia is liable to be produced by a variety of causes; and every abnormal state or unusual circumstance occurring during labor likely to result in this critical and dangerous condition to the infant, should be carefully weighed by the attending obstetrician, so as to be prepared to promptly meet the emergency, should it arise.

On the announcement to the profession of Dr. Marshall Hall's "ready method" in asphyxia, some years ago, and its practical application in a few cases, the writer thought there was very little, if any, further addition necessary to the list of remedial agents in the asphyxia of newly-born infants. Later experience, however, with this and subsequently published "methods," proved that, occasionally at least, all the then known appliances were futile, and further knowledge required to secure success in the management of this very dangerous condition of the infant.

The following "method," it is believed, will be found a highly valuable, if not the most important, addition to our list of appliances in the asphyxia of children, and also for the relief of that condition in the adult when properly manipulated. The procedure is easy of accomplishment, and requires no preliminary arrangement or preparation for its application, but may be put into execution the moment the condition of the child may demand it. It is as follows: Bring the *ulnar* sides of the hands near together, with the palmar surfaces looking vertically, and place them beneath the back of the infant, so that the extended thumbs may aid, as far as possible, in sustaining the vertex and inferior extremities; then, keeping the *ulnar borders* near together, so as to form a fulcrum, the radial borders or sides are simultaneously depressed to as great extent as practical—say forty-five degrees—*below* the horizontal line, and then gradually pronated or elevated to as many degrees *above* that line, thus facilitating the escape of air drawn into the lungs during the downward movement of the head and chest. Or the hands are placed as at first, and passed *beneath* the body of the child—on its back—and the superior and inferior extremities furthest from the operator seized, one by each hand, near the trunk—the *ulnar borders* of the hands and wrists forming the fulcrum—the head of the child being kept at a proper axis with the movements of the chest by the hands of an assistant; and the depression and elevation of the head and lower extremities proceeded with as already described. These alternate depressions and elevations of the two extremities, performed in a regular and gentle manner, and repeated at proper intervals, seldom fail in establishing respiration where it is possible of accomplishment. The occasional dashing of cold water on the epigastrum during the *descent* of the head and chest will hasten respiration where the first few movements fail in its establishment. It is important that the head be kept as far as practicable from too

No 1.

No 2.

much *lateral* movement, and not permitted to depart considerably from its *antero-posterior* axis with the vertebral column during the continuance of the process. To this end, in a critical case, the hands of an assistant may be brought into requisition.

The importance of these remarks will be apparent to intelligent readers on a moment's reflection. No impediment should be *permitted* in the way of *free entrance* of air into the lungs during the *downward* movement of the head; and it is *scarcely less important* that no *obstruction* should oppose the escape of air during the *upward* movement of the head and chest.

The philosophy of the above-described movements will be easily comprehended by a glance at the accompanying woodcuts. A nurse or other intelligent attendant can be made to understand the movements, so as to continue them should the condition of the mother demand the attention of the accoucheur. These movements will apply to the treatment of asphyxiated persons of *any age*, as has been practically demonstrated in several cases since the publication of my first article on the subject.

Asphyxia from drowning has been promptly overcome in three instances since the question was asked in a former communication—on theoretical grounds—whether it would not act more promptly than *any other* method. It has been found that the "movements" are easily practiced when the body is taken from the water and placed on its back across a barrel, trunk of a fallen tree, or other substance. Two persons can thus depress and elevate the extremities as often as necessary to expand and exhaust the air in the lungs, as in normal respiration. The epiglottis acts in these movements in a manner similar to the valve of an ordinary bellows when being used.

Since my first article appeared—in 1870—on the value of the "speedy method," quite a number of cases of asphyxia have been treated by it, and its value thoroughly tested in my own practice, and in consultation with professional friends, and always with the most gratifying results.

Further experience has proven that where a sufficiently large tub or basin of warm water can be had, the movements already described may be carried more easily into operation than otherwise. Care should always be had, of course, to avoid depressing the head to such an extent as to permit the water to enter the mouth or nostrils of the child during the operation. In practicing the "method" *in the water* the head need not at any time be elevated above the surface—the body of the child alone being elevated or depressed—for the inflation and exhaustion of the air in and from the lungs. A number of cases could be recorded in favor of the method since the previous reports were made, but they are deemed unnecessary at this time.

The object of this communication is to give greater publicity to a most important remedial procedure, and we may here repeat what has already been proven to be true by many practitioners, "that those who may have occasion to employ this method will agree with us that in the asphyxia of children it is the remedy *par excellence*."—*The Practitioner.*

WASHING OUT THE STOMACH.—A CURE FOR DYSPEPSIA.*

THE patient is a man some fifty-five years of age, and by occupation a cardriver. He says that he has never been more than a moderate drinker. Two years ago he began to be dyspeptic, and lost his appetite. He found himself also obliged to urinate frequently at night. There was no dropsy apparent upon admission, but he vomited frequently, and was, in fact, one of those most unfortunate of beings, a wretched dyspeptic. His tongue was thickly coated, and his urine alkaline and phosphatic, but free from albumen and sugar. The abdomen was distended, and the epigastrium tender. He was, in other words, flatulent and constipated, with symptoms of marked organic dyspepsia.

We kept him in bed for a time and gave him complete rest, and set ourselves at work to find out the cause of his

* A clinical lecture, delivered at the Pennsylvania Hospital, Philadelphia, by J. M. Da Costa, M.D., Professor of the Theory and Practice of Medicine, and of Clinical Medicine in Jefferson Medical College.

dyspepsia. Perhaps the numerous and painstaking examinations which were made in the wards can be usefully repeated to some extent in your presence this morning. Let me examine the patient as if this were the first time I had seen him.

His toague is somewhat less coated than it was, but is still far from clean. The resident tells me that he still vomits once in a while, that is, once in every two or three days. These spells of vomiting occur generally at night, or near the end of the day. At such times the contents of the stomach come up in large quantities—sometimes the vomit appears to represent the whole of several meals. This vomit has a thick froth on the surface, which smells and looks like the froth of beer or yeast, and leaves a heavy deposit on the bottom of the vessel.

"Have you ever any pain in your stomach?"

"Yes; I have cramps in my stomach occasionally, but not often."

These cramps are generally at night, and come from overdistention of the stomach. They were very much more marked just after he was admitted than they are now. There has upon no occasion been any vomiting of blood.

To what does all this point? It points unquestionably to some organic disease of the stomach. To what organic disease does it point—to cancer? The patient is at the cancerous age, and the vomiting at night looks very much as if there were some mechanical obstruction, such as cancer, to the free passage of food into the pylorus. I examine the region of the stomach, and particularly its pyloric extremity, for a tumor, but can find none.

I percuss the region of the stomach, but can detect no dullness. On the contrary, I find the stomach tympanitic as far down as two inches below the navel. There is plainly a very unusual increase in the size of the stomach. There is no tenderness on pressure, no spots of soreness, no pain in the back. These points have a direct bearing upon the existence of ulcer or cancer. These are negative symptoms.

Under my supervision the resident physician has made a most careful microscopical examination of the vomited matters, and, just as we had expected, he found a great many bodies like this figure, which I outline on the blackboard, floating about in the vomit—the so-called *sarcinæ*—a peculiar vegetable fungoid growth, described by Goodyear, and almost always associated with this yeasty vomit—this obstinate dyspepsia, and this dilated condition of the stomach. We have then here one of those rare cases of dilated stomach with narrow pylorus, unattended by either ulcer or cancer.

What are my reasons for thus positively excluding these two conditions? First, as regards my reasons for determining upon the existence of dilatation, they are: (1) because percussion shows an unusually extended area of tympany; (2) because a yeasty vomit containing saracinæ is very apt to be present in dilatation of the stomach, whether from cancer or any other cause; (3) on account of the way in which the vomit occurs, the accumulated results of several meals being cast up at a time.

My reasons for excluding cancer: (1) the absence of pain upon pressure; (2) the absence of any tumor; and (3) the absence of blood in the vomit.

My reasons for excluding ulcer: (1) the absence of pain after meals; (2) the absence of hemorrhage; and (3) the absence of points of local tenderness.

What has our treatment been? Since I have had charge of the case I have treated the patient with bismuth, giving him gr. xv. between meals, and gr. x. of pepsin at meal time. At the same time we have regulated the patient's diet and attended to his bowels. We also have given him gtt. x. of the tincture of nux vomica before meals, with evident benefit. His tongue is cleaner, and he has gained flesh. To modify the process of fermentation in his stomach, he has been taking gtt. i. of the concentrated carbolic acid, diluted with water and glycerine, once a day. His diet is chiefly fluid, consisting mainly of milk, oyster broth, and beef tea.

Shall we continue this treatment, now that we thoroughly understand the case, or shall we modify it? The same dose of bismuth shall be continued; so, too, with regard to the small doses of nux vomica before meals, and of pepsin with meals.

But we do not seem to be fulfilling the indication of checking fermentation, or doing anything to reduce the dilatation of the stomach. This brings us to the question of how to check the multiplication in the stomach of these agents which are associated with the fermentation. The best means at our command for accomplishing this end are sulphurous acid, the sulphites, and carbolic acid. In this case I shall order gr. ½ of carbolic acid four times a day in glycerine and water, and if this dose does not put a stop to the presence of sarcinæ, we shall have to resort to sulphurous acid or the sulphites.

Upon several occasions, in cases such as the present, I have made use of the German plan of washing out the stomach, and in so getting rid of the foul secretions. In this manner I have in several cases effected an actual cure. The treatment by washing out the stomach is very annoying, but also in some cases very successful. I will perform it in your presence to-day.

Washing out the stomach in chronic cases of dyspepsia, and particularly in those cases in which that organ is dilated, is a plan of treatment that, while it is not altogether new, may still be said to be so, since it has only become a regularly systematized form of treatment since Kussmaul introduced it.

The object aimed at by this method of treatment is to get rid of the large amount of fermented matter remaining in the stomach—matter which cannot otherwise be gotten out of the organ, and which, remaining in it, impairs digestion, ferments, and makes the patient's life wholly miserable, while it at the same time weakens the system and increases the dilatation of the stomach.

Simple lukewarm water was first employed for this purpose, but subsequently weak alkaline solutions of carbonate of sodium were tried. This latter medium is that recommended by Kussmaul.

In no instance should the operation of washing out be performed more than once a day, and, when the case is not a bad one, once in two days will be sufficient. The best time for the operation is in the morning.

The plan of the operation varies. Some clinicians use the siphon arrangement, while others prefer the ordinary stomach pump. There is not much difference between the two, except that the siphon is more convenient and is not apt to suck the mucous membrane of the stomach into the holes of the tube, as happened in one published case in which the stomach pump had been employed.

The patient will now be put upon his side, and the assistant will perform the operation of washing out the stomach in your presence, in just the same manner in which it has been done in the wards.

All that is necessary when the siphon is used is a tin vessel, an elastic tube, and an ordinary stomach pump tube. When the tube has been inserted well into the stomach the vessel containing the alkaline solution is held above the patient's head. You see that the liquid flows in rapidly—is now all gone—but the liquid does not flow back out of the tube as easily as it usually does. Probably there is some hard morsel of food clogging up the tube. This accident, or rather its possible occurrence, is the only reason why the stomach pump is preferred by some. Its advocates hold, and with reason, that it is not possible for the tube of the stomach pump to become clogged with food morsels.

I think that, in future, I shall use the stomach pump for this purpose myself, instead of the siphon arrangement. The operation is at best such a disagreeable one that it ought never to be undertaken rashly.

The conclusions which I have reached with regard to this operation of washing out the stomach are: (1) that it is an operation to be restricted to a particular group of cases—those in which we have some obstruction at the pylorus, with dilatation of the organ, so that the contents of the stomach are not readily passed out of it; (2) that if accompanying the dilatation there be structural disease of the stomach, such as cancer, washing out the stomach rarely does good, except it be to get rid of accumulations which cannot otherwise be removed.

Have I ever known of any good results following its use where the cases were suitable ones for its employment? Admirable results. In such instances I regard it as being the best method of treatment at our command. Even in one case of ulcer of the stomach in which cicatrization has now occurred, and where there was constant vomiting and great emaciation, the patient made a slow but sure recovery under this plan of treatment, in conjunction with a carefully regulated diet.

Are there any other means to assist us in the treatment of this condition? you will, no doubt, and with perfect propriety, inquire. Nux vomica is a very important adjuvant. At the same time the diet must be regulated. Small quantities of solid, and not too much liquid, food must be given. If the fermenting contents of the stomach cannot be gotten rid of, and if you do not wish to make use of the washing-out process, a brisk cathartic will often be found to be of great assistance. In this way you are enabled to cause the mass lying in the stomach to pass out and on into the bowel. Indeed, in all cases of dilatation of the stomach, an occasional brisk purgative will be found to be a much better method of treatment than the old routine plan of administering emetics. The act of vomiting is always more or less exhausting, and in cases of great dilatation of the stomach it is often a matter of great difficulty to excite vomiting by any amount of emetics, since the muscles of the stomach, being so distended, are slow to react to irritants.

The patient was brought before the class a few weeks later and presented the following conditions: the vomiting had stopped entirely; the natural powers of the stomach had been so far restored that the patient was able to digest a moderate meal without any great inconvenience; his tongue was much cleaner, and his stomach, upon percussion, showed a well-defined decrease in the amount of dilatation.

As the vomiting began to stop the sarcinæ in the matter vomited gradually disappeared. Dr. Da Costa attributed this decrease in the number of sarcinæ partly to the washing out of the stomach, and partly to the remedies employed to stop fermentation. These remedies consisted at first in one grain of concentrated carbolic acid, well diluted, and, later, in f. ʒi. of sulphurous acid in water, thrice daily.

It was thought that there was no longer any necessity for washing out the stomach (the man had received so much benefit from this washing that he grumbled considerably when the order was given to discontinue it), but that the patient should take ten drops of the tincture of nux vomica thrice daily, and should be allowed a little more varied diet, a small amount of sulpburous acid being given occasionally after meals. The bismuth had been long discontinued.—*Medical Record.*

[KANSAS CITY REVIEW.]

MAN AND EVOLUTION.

By the late Prof. B. F. MUDGE.

EMBRYOLOGY.

LET us take man as a single species of the animal world, and see if there is anything in his history or physical construction which justifies the conclusion that he has been developed from the ape or any lower type. Here, in the beginning, we are met with the claim that embryology is entirely against us. While we admit that on a hasty examination of that branch of natural history it appears to favor evolution, yet we think the claim in favor of development will not bear careful scrutiny. Evolutionists tell us that the human subject before birth passes through all stages of animal life, from the mollusk through the type of fish, reptile, bird, dog, and monkey, to man. Some have even given the exact stage and month * in which we were each one of these lower animals before birth.

Our answer to this is that, while the embryo may, at its very early stages, have some approach to an elementary form, it is in appearance only, and not in reality. That the future man is, from the starting point, a human being, is apparent from the fact that the traits of the father are constantly reappearing in the son from generation to generation. But if the offspring were ever fish, reptile, or monkey, and developed during gestation into a man, it would be, when born, only human and never endowed with the personal traits of the father. The mother might give it a human form, but neither father nor mother could impress any personal traits upon the child. But we see, every day, in the color of the hair, contour of the face, the gait, and tone of the voice, the father reproduced in the son. We notice it at the first sight of the child or grandchild of an old acquaintance.

More than this, if we will go to the monuments and tombs of Egypt, we shall see, depicted on their walls, the faces of the oldest residents of Thebes and Memphis—the Copt, Bedouin, Fellah, and Jew; and you can go among the inhabitants of that country to-day, and select the representatives of the portraits, 3,500 years old, and see the traits of fathers reproduced after more than a hundred generations. The Hebrew of old Egypt gives the same contour of face and physiognomy which his descendants exhibit in the cities of America, and this, too, when that race has been an inhabitant of all the various climates of the world. Could the personal minor traits have been preserved from father to son, if man had in that period been a hundred times a fish, reptile, dog, and monkey?

But we are not left without some facts to aid us on the question of embryology. The spermatozoa of man and other male animals are so entirely different, in relation to size and shape, that we need not give diagrams to prove the fact.* Though exceedingly small, the sperm cells of our common animals not only differ from those of man, but they persistently differ, each from the other, in size and form. Yet these minute, microscopic spermatozoa of the father fix the future lineaments of the child, including its mental traits and tendency to inherit mental diseases.

The human ovum has not, for various reasons, been so carefully examined under the microscope as the sperm cell; consequently we cannot speak of its clear difference from the ova of other mammalia. The germinal spot in the ovum from which the embryo man is formed is, according to Gray, only from $\frac{1}{175}$ to $\frac{1}{125}$ of an inch long.

As we find the male sperm cell so much unlike that of all other mammalia, so we have a right to expect the female germ cell, if we could submit it to an equally high power of the microscope, would be equally human in its structure. When this shall be done, we believe as marked a difference will be found between human and animal ova as between the spermatozoa. This opinion is strengthened by the fact that the Graafian vesicle, or ovisac, which contains the ovum, varies in structure in different genera of mammals. It would be a great anomaly in nature if, while the male element and the Graafian vesicle are so distinct, the female germ cells should be alike in all mammalia. As its first segmentation after impregnation shows it to be a vertebrate, and not a mollusk nor crustacean, so almost the next change shows a difference from other vertebrates in its embryonic condition. Before the first month it can readily be distinguished from fish or reptile. By the twentieth day the segments which form the different portions of the head are developed, and by the end of the first month the human head is clearly defined.

The latter change deserves especial notice. The head or cephalic development is more prominent and clearly defined than other portions of the body. The brain cavity is large from the early portion of the second month. The brain matter is very albuminous and very human. The forehead is even larger than in the developed babe, and it is a well-known fact that children at birth have relatively larger brains than mature men. Instead of requiring nine months to pass through the various stages from mollusk to monkey, it is, in less than one-fourth of the period of gestation, so well developed that the head cannot be mistaken for that of an ape.

At less than two months the difference in the sex can be detected, and at the close of the second month the toes, fingers, mouth, and nose are clearly formed.† The heart, which during the first month is as simple as that of a reptile, does not long continue so. Carpenter says:

"A change in the type of the circulatory system of the fœtus, from that first presented by it, takes place at a very early period. At about the fourth week in the human embryo a septum begins to be formed in the ventricle, and at the eighth week it is complete. . . . During the same period a transformation occurs in the arrangement of the arterial trunks proceeding from the heart, which ends in their assumption of the form they present until the end of the fœtal life; and this undergoes but a slight alteration when the plan of the circulation is changed at the moment of the first inspiration."‡

Thus before the human fœtus has passed through one-fourth of its period of gestation, it becomes distinctly human in sex, circulation, and brain; and after that period, if not sooner, its resemblance to lower types of animal life exists only in imagination.

We give in the figure the head of a fœtus "about the end of the second month," from Dalton.§ It will be seen that, so far from a resemblance to a low vertebrate, it is superior to the highest ape. Instead of a resemblance to any of the lower types in its embryonic state, the "cephalization" ‖ is almost an exaggeration. According to Dalton, the brain encephalon of the new-born infant exceeds that of the adult man in the proportion of 148 to 23, or relatively more than six times larger. If cephalization ¶ is a standard of rank, as all our best scientists agree, surely the human infant, either before or after birth, is in no sense typical of a low form.

We are aware that there are some scientists of high reputation that have made statements at variance from this. Packard says: "The human form is clearly indicated by the seventh week, the subsequent changes consisting in the remodeling of the outlines, in which it passes through a generalized ape-like figure, until the human form is shaped out."** Instead of an ape-like figure, we have from the first month a head which is far from that likeness. Let any one visit any well provided medical museum in one of our large cities, and he will find a set of embryo skeletons for each month. From them he will see that the head is not ape-like, but the fully developed brain, in all stages, is clearly defined. In size and proportions it is most strikingly human, and the only objection is that the resemblance is to a type more intellectual than man. Nor is the figure in hands and feet related to the ape, but the fingers and toes

* See preliminary table in "Vestiges of the Natural History of Creation."

* See Carpenter's Physiology, § 643, p. 730, plate I.; Dalton's Physiology, p. 557; Morel's Human Histology, plate XXI.

† Carpenter's Human Physiology, plate I.

‡ Human Physiology, § 895.

§ Human Physiology, Fig. 943.

‖ Cephalization—the brain and head structure compared with other parts of the body.

¶ *Ibid.*, p. 639, quoting Cruveilhier, Solly, Wilson, etc.

** Life History of Animals, Including Man, p. 295.

are seen in the second month. This fact will be apparent by consulting any good illustrated work on midwifery or human physiology.* The limbs and fleshy portions of the early fœtus are also unlike the ape form.

Darwin gives us a figure† from Ecker, of a human embryo ten lines long, having a clearly defined tail, which he compares with the embryo of a dog, relatively much farther advanced, having a similar tail. We have sought in vain in all our standard works on physiology for a similar form in a fœtal state, though the books abound in diagrams of the earliest shapes. We have also examined many fœtal embryos, some of even less size and in an earlier stage of gestation than Ecker's example, and never found one similar to it. Nor, on inquiry of physicians of extensive practice, have we met with any who has seen such a form. Aside from the tail, the head and vertebræ are relatively more advanced than the arms and legs in specimens coming under my observation. It is true that in the human embryo the coccyx, which represents the tail, is proportionally larger than in the adult, but, in all the cases we have examined, it lies under the skin as in the mature individual. Ecker's figure gives twenty-one clearly defined vertebræ (omitting the cervical) in process of development. We have never found the vertebræ so distinct in embryos twice as old. The first rudimentary back-bone is so indistinct and covered with flesh that it cannot be seen in an ordinary specimen at so early a stage. Even when the vertebræ are found, by dissection as clearly as there delineated, the limbs, with fingers and toes, are distinctly outlined. But in Ecker's figure the legs and arms are only round, blunt knobs. From all these facts we conclude that his example is not a normal one, but in reality an imperfect fœtal form. Either his, or all I have seen, are not ordinary specimens of fœtal development.

Commenting on this figure (and others where the head and neck are correctly represented) Darwin says: ‡

"At this period the arteries run in arch-like branches, as if to carry the blood to branchiæ which are not present in the higher vertebrata, though the slits on the sides of the neck still remain, marking their former positions."

These "slits" other evolutionists have frequently claimed as gill openings. They, however, are not slits or the marks of slits, but are, as Gray and others have plainly shown, the pharyngeal arches, which a little later become developed into jaws, hyoid bones, and soft parts of the neck. No one has ever found the semblance of gills, and these so-called slits are clearly not connected with gills, lungs, or with any breathing organ. On the other hand, the lungs of the human embryo, as soon as it has any definite shape, assume the mammalian form. Low reptiles, like the salamanders, have, as lungs, two long cylindrical sacks, extending nearly the entire length of the body. The higher type of reptiles, like the frog, have broader, flat lungs, but the position in the body and the arrangement of the cells and small air tubes are still quite reptilian. The lungs of the birds, the type next above the reptiles, are, as is well known, very peculiar, and line much of the interior of the body. But the position of the lungs in the human fœtus is, from its earliest stages, always in the chest, and they never assume the reptilian or bird form in shape or in the arrangement of their air passages. These various facts can be verified by any one who will dissect an aborted fœtus in its earliest stages, and compare its internal structure with the low animals which we have named. The little form, three-fourths of an inch long, has limbs that have not the least shape resembling the fin of a fish or wing of a bird.

The development of the embryonic heart, in like manner, does not pass, as it is asserted, through the fish and reptilian types. True, in the earliest stage it has but two cavities, irregular in shape, which might, by an effort of the imagination, be considered as similar in form to the double chambers of the heart of the fish. But these two imperfect chambers lie side by side as in the double heart of all mammals, while in the fish one lies in front of the other, as auricle and ventricle should. But, if we allow this stage to be fish-like, the next stage is not reptilian, as evolutionists have claimed; for the fœtal heart at its next stage has not the three chambers, one ventricle doing double duty to a pair of auricles, but two ventricles and two auricles, with the double circulation of a perfect organ of the high mammalian structure. This is complete at the second month of gestation, when, according to the author of the "Vestiges of the Natural History of Creation," it is yet in its supposed fish stage. It must, however, be clearly kept in mind that the circulation and purification of the blood in the embryo are not by the action of its own heart and lungs, but, up to the moment of birth, they are by the action of the heart and lungs of the mother, the current passing through the umbilical cord.

We shall be reminded, also, that man has some rudimentary, useless muscles and organs, some of which are useful in the lower animals. This certainly favors the development theory; but we think that more importance has been credited to the facts than they deserve.

The *appendix vermiformis*, so useless and sometimes so injurious in man, is supposed to have been derived from an animal of a lower type. But as it is found in marsupials§ and some of the monkeys, mammals most widely separate, and not in most of the intermediate types, and is always a useless organ, we cannot perceive that it has any bearing on this question.

The caudal muscles, so useful in animals with a tail, are found rudimentary in man. They are also found in nearly all of the tailless apes, and if derived from the lower orders of monkeys, why did not the development which shed the tail act harmoniously and drop the caudal muscles also, or at least shed them entirely before the ape could have made that much greater advancement and become a man?

In this connection it is well to recollect that a tail has little or no connection with the rank of an animal. Man has four caudal vertebræ, and many of the higher apes have the same number, and also the low, slender lemur (*loris*), while the Barbary ape (*Macacus inuus*) has but three. On the other hand, the *Semnopithecus*, higher in rank than the *Macacus*, has thirty-one. The reader will readily recall many common animals with very short tails.

FOSSIL MEN.

A careful examination of man's geological history confirms us in the opinion that he always has been a man, and was not derived from a lower type. As the theory of the extreme antiquity of our race is recognized very generally by the scientific world, we shall assume that fact as settled.

Dana, our great American geologist, places man "at least as early as the alluvian part of the warm Champlain era, and probably earlier."* As the Champlain era preceded the Delta period, and also the period of the elevation of land over the high latitudes of North America, we can hardly place this, on the received principles of geology, at less than 200,000 years.† The question then arises, What has been the condition of man during this long lapse of years, judging from his fossil bones and the remains of his domestic implements?

When the doctrine of the antiquity of the human family was in its early stages, the celebrated Neanderthal skull was found, presenting a singularly low intellectual conformation. The flat, receding forehead, prominent superciliary ridges, and other traits, were so characteristic of a low intellectual condition that it was immediately claimed as evidence that the oldest fossilized races were far lower than those now existing. This, in fact, is now claimed by some popular writers on the side of evolution. But subsequent discoveries have not sustained this conclusion. Though the Neanderthal skull has more than twice the cubic capacity of the gorilla or any other ape, no other fossil human skull has been found of so low a type; but, on the other hand, the large numbers since discovered, many of them far older than this, compare favorably with the existing races. The skeleton of the Neanderthal specimen does not differ from the average skeleton of living men.

The Borreby crania are the nearest in form and character to the Neanderthal, but Prof. Huxley states that there is a marked resemblance between them and the Australians.

On the other hand, the Engis skull, which is far older, probably twice as old as the Neanderthal, "approaches," in the language of Lyell, "near the highest, or Caucasian type." Huxley calls it a "fair average skull, which might have belonged to a philosopher, or might have contained the thoughtless brains of a savage." Dana says "the cranium was high and short, and of good Caucasian type, though of medium capacity."

The Calaveras head, from California, one of the very oldest, whose antiquity and authenticity are now so well established, though possessing some Indian traits, is nearly up to the average of the European. It was found 132 feet below the surface, under four beds of lava and in the fifth bed of gravel, alternately deposited in a gold mine. When first presented to the scientific world, its authenticity was doubted. Those who favored evolution objected to it because its structure was so near that of the skulls of existing races. Not only has the average human cranium been preserved for so long a period, but many of the peculiarities of the typical Indian.

Prof. Whitney has quite recently presented some additional remains, between thirty and forty instances, from the same or similar beds, showing strong evidence that man is Pliocene. Then the Neanderthal skull is quite modern. Prof. Whitney adds, as one of his conclusions: "Man, thus far, is nothing but man, whether found in Pliocene, Post-Pliocene, or Recent formations."

In 1875 there was exhumed near Worthing, England, the skeleton of a woman, which was presented and described by Prof. Rolleston at a meeting of the British Association.‡ It belonged to the earliest Neolithic age, and the skull had a cubic capacity of 105⅝ inches, or about 13 inches above the average of the European. The shape of the skull was of a good form, above a medium.

The oldest human remains known, excepting those of California, are probably those found at Mentone, near Nice, in 1872 and subsequently, and are of the Paleolithic age.§ The best was in excellent preservation, and Rivière describes it as having "a rather long, but large head, high and well made forehead, and very large facial angle—85°." Prof. Huxley gives a similar description.

It will thus be seen, from the few examples quoted, and which may be considered fair specimens of the whole, that fossil men differed as much among themselves as those now living, and at the same time were closely similar to the present races.

Broca,‖ before the French Association, makes three races of prehistoric men, viz.: Constadt, Cromagnon, and Furfooz. The names are derived from the three localities where the remains are found. The first, or oldest, he places in a low rank of intellect, but not lower than some now existing. This race is founded on a few bones, and, we believe, is represented by no entire skull. The Furfooz he also places in a low rank. But the intermediate or Cromagnon race, he ranks as the highest, and says its crania are equal, if not superior to the modern Parisian, or in type closely approaching the Caucasian. It will thus be seen that Broca does not find a regular grading upward from an oldest low intellect to the highest in the modern, but that the intermediate prehistoric race was nearest to the best living races. The earliest are not more degraded in intellect than some of the present tribes of the human family. The oldest remains of man in Europe, where the search has been the most untiring, differed about as much as, but no more, from each other than those now living.

Broca's account appears to coincide with the observations of Huxley, Lyell, and others, in giving the most ancient races an intellectual condition very similar to, if not identical with, those of the present day.

The tools and implements of the most ancient men are of rough stone, showing a low civilization; but the structure of the head shows the ability, from the first races, to become civilized. Just as the first fossilized hogs, from the beds of the earliest Eocene, were typical hogs, so the earliest men were in brain and skeleton identical with those of to-day.

There is no peculiarity in the structure of the skeleton of the oldest human remains which is not found in existing races. Nor is the size shown to be greater. The best Mentone man is probably the largest fossil, with one exception, of the human race, and he was not over six feet in height. The close resemblance between the first and the living races is recognized by the ablest authorities who favor evolution.

Wallace says: "The few remains yet known of prehistoric man do not indicate any material diminution in the size of the brain case."¶

Prof. Darwin says: "At the most ancient period of which we have as yet obtained any record, the races of man had already come to differ nearly, or quite as much, as they do at the present day."**

Huxley, after a long description of the oldest prehistoric skulls, says: "In no sense can the Neanderthal bones be regarded as the remains of a human being intermediate between man and the apes." He further adds: "The [illegible] traces of the primordial stock whence man has proceeded need no longer be sought by those who entertain the doctrine of progressive development, in the newest Tertiaries, but they may be looked for in an epoch more distant from the age of *Elephas primigenus* than that is from us."*

Lyell, too, who claims a greater antiquity for man than Dana, in his last work says: "Yet in spite of the long lapse of prehistoric ages during which man must have flourished on the earth, *there is no proof of any perceptible change in his bodily structure.*"†

Can any anti-evolutionist use stronger language? If two hundred thousand years, or perhaps five hundred thousand years—seven thousand or fifteen thousand generations—have not made "any perceptible change in his bodily structure," how long will it take to develop him from a reptile or from an ape?

If we follow others, as Abbott and Shaler, Tiddeman, Geikie, Pengelly, Ramsey, etc., in assigning man to an inter-glacial age, or Professor Marsh, Whitney, and others that he may be from the Pliocene, the argument is still stronger in our favor; for, according to the authorities cited, no form intermediate between man and the apes has been found, and the structure of our race has been always the same. The farther back we accept the antiquity of the human family, either in geological deposits or in years, the more forcibly becomes the fact, that time and environment cannot have developed man from a low animal.

* See Leisman's Midwifery, p. 131, Fig. 73; Flint's Human Physiology, edition of 1876, plate III, Fig. 1.

† Descent of Man, Fig 1, p. 15.

‡ Descent of Man, p. 14.

§ Huxley—"Anatomy of Vertebrate Animals," p. 260.

* Manual, p. 576.

† See *Kansas City Review*, August, 1879, p. 222.

‡ See *Nature*, September 7, 1875, p. 419.

§ *Nature*, September 7, 1875, p. 419.

‖ See a brief report in *Nature*, August 30, 1877.

¶ Limit of Natural Selection, p. 396.

** Descent of Man, Vol. II., p. 366, American Edition.

ARE THE OCEANS DISAPPEARING?

AT a recent meeting of the French Geological Society a communication from M. Trantschold, of Moscow, was read on the non-invariability of the level of the ocean. It terminated with the following conclusions: 1. In proportion as certain parts of the earth's crust rise from the bottom of the sea above its level, the latter must be lowered. 2. The surface of nearly all the present continents has been at one time the bottom of the sea. It rises from the water partly by reason of upheavals, partly because of the retreat of the ocean. 3. As continents are formed, one part of the water of seas is transported to them in the form of lakes, rivers, eternal snows, glaciers, and organized substance. Owing to these actions the water of the ocean has diminished in a constant manner, and its level has been lowered. 4. In proportion as the earth cools down, ice accumulates near the poles and on mountains, water is imbibed more deeply into the terrestrial crust, and the formation of hydrated minerals is manifested everywhere. It results from all these facts that since water existed on the surface of the earth the level of the sea has been gradually lowered.

* Observation on Human Skulls from Engis and Neanderthal.

† Antiquity of Man, p. 540. The italics are ours.

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TABLE OF CONTENTS.

I. ENGINEERING AND MECHANICS.—Explanation of the Bogie System of Locomotives. 1 illustration. Bogie Locomotive for the Denver, South Park, and Pacific Railway. 3431
Six-coupled Tank Locomotive. 1 illustration 3431
Central Feed Steam Boiler. 1 illustration. Central feed steam boiler. Sectional view. 3432
Steam Pressure Lubricators. 2 figures. Sectional views. 3432
The Sahara Desert Railway 3433
How to Ascertain the Inclinations of Borings. A novel instrument and its remarkable results. 1 figure. 3433
Norwegian Lighthouses 3434
Napier's Show Speed, or Speed Indicator. 1 figure. 3434
Fast Speed of Vessels 3435
Parrott's New Bath Dynamometer. 3 figures. Front view, side view, and sectional view 3435
Chilled Cast Iron Armor. Gruson's System. 14 figures. Effect of shot on wrought iron plates. Effect of shot on cast iron shield. Section of revolving cupola. Plan of battery. Mode of erecting cupola. Line of chilled iron cupola built for Prussian Government. St. Marie Battery, Antwerp. Interior of St. Marie battery. 3436
The Tay Bridge Disaster. 1 illus. Searching for the lost 3437
Compressed Air Refrigerating Apparatus. By HENRY BELL, JAMES BELL, and JOSEPH JAMES COLEMAN, Glasgow. 1 figure. Section of apparatus 3438
Machine for Cleaning Wool. Hubner's machine. 2 figures. Side elevation. Plan 3439
Improved Kneading and Mixing Machines. 11 figures. Details of Pfeiderer's machines. 3440
Artesian Wells, and the Great Sahara. By Lieut. SEATON SCHROEDER. A study of the various plans proposed and in operation for improving the Sahara Desert 3441
Improved Filter. 2 figures 3442
A System of Electrical Storage. By Profs. EDWIN J. HOUSTON and ELIHU THOMSON. 2 figures. 3443

II. MEDICINE, SURGERY, HYGIENE, ETC.—Skin Grafting. By Dr. J. B. LEWIS. Methods of operating.—Size of Graft.—Effects. 3443
Hygiene in the Higher Education of Women. By Dr. A. HUGHES BENNETT. Why women who follow intellectual employments break down.—The physical conformation of woman.—The nervous conformation of woman.—The intellectual conformation of woman.—The disposition of woman.—The effects of social life and education on women. 3447
Asphyxia. By Dr. HARVEY L. BYRD. A speedy method of treating asphyxia in the newly born and in drowning. 3 figures. 3447
Washing Out the Stomach—A Cure for Dyspepsia. A clinical lecture by Dr. J. M. DA COSTA, Philadelphia Hospital. 3448

III. BIOLOGY AND GEOLOGY.—Man and Evolution. By Prof. E. P. MUDGE.—Embryology.—Fossil men.—A powerful and critical argument against the theory of evolution as applied to man. 3449
Are the Oceans Disappearing? 3449